SORENSEN
POWER SUPPLIES

Instruction Manual
STM Series

HIGH EFFICIENCY SWITCHING POWER SUPPLIES

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587327 (3/81)
REV. A
PRINTED IN USA

SORENSEN
POWER SUPPLIES

instruction manual for STM SERIES MODULAR DC POWER SUPPLIES

INCLUDES THE FOLLOWING STM MODELS:

MODULE III		MODULE III-IA	
3.5-24	18-10	3.5-36	18-15
5-24	24-8.5	5-36	24-13
9-12	28-7	9-20	28-11
12-12	36-4	12-20	36-6
15-10	48-4	15-15	48-6

SORENSEN POWER SUPPLIES SORENSEN COMPANY
A RAYTHEON COMPANY
676 ISLAND POND ROAD MANCHESTER, NEW HAMPSHIRE 03103

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SORENSEN COMPANY

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1 INTRODUCTION

1.1 PURPOSE

This manual contains operation and maintenance instructions for the STM series of high efficiency modular dc power supplies, manufactured by the Sorensen Company, Manchester, New Hampshire. The STM models included in this manual are similar in electrical design and physical appearance. They are grouped into two module sizes; III and IIIA, differing only in size and in power output ratings. (Refer to Table 1-1, Unit Specifications.)

1.2 GENERAL DESCRIPTION

The STM series provides a variety of highly regulated dc outputs and is designed for operation on 115 Vac or 150 Vdc. The line also offers exceptionally high efficiency and fast recovery times as well as characteristically low output impedances.

The supplies are designed for mounting in any of three attitudes; end, bottom or side. Four tapped mounting holes are provided on each side. Section 2 provides necessary installation data.

1.3 FUNCTIONAL DESCRIPTION

Operational features of the STM series power supplies include remote sensing (regulating), remote programming, overload and short-circuit protection by automatic current-limiting, and over-voltage protection through an integral electronic crowbar shorting circuit.

1.3.1 Remote Sensing

For applications where variation in the load-lead voltage drop may adversely affect load regulation, remote sensing may be used to establish the regulating point at the load rather than at the output terminals.

1.3.2 Remote Programming

The STM series power supply outputs may be altered from a remote location by either the resistance or the voltage programming methods. For resistance programming, a calculated value of resistance at the ratio of 1000 ohms/volt is inserted in the programming network. For voltage programming, a value of voltage at the ratio of 1:1 is inserted.

1.3.3 Series Operation

For applications requiring output voltages higher than a single unit can provide, STM units may be connected in series to a maximum total of 200 Vdc. Regulation in series operation is the sum of the regulations of all units.

1.3.4 Parallel Operation

Consult factory for requirements.

1.3.5 Over-Current Protection

In the event of an excessive current condition, such as a short-circuit, a current-limit circuit acts to reduce the unit output voltage. This circuit is factory-set to at least 110% of the unit rated output current at 40°C (+104°F).

1.3.6 Over-Voltage Protection (OVP)

In the event of an over-voltage condition on the output, such as a failure in the power supply or an externally induced condition, an over-voltage electronic crowbar is actuated by an integral OVP sensing circuit. The crowbar acts to quickly reduce the output voltage to zero and to disable the input dc circuit.

1.4 ACCESSORIES

Several universal rack-mount adaptors are available for the STM series. For specific information on these adaptors, contact your service representative, or the factory.

Table 1-1A Common Specifications

Input Rating:	AC: 105-132 volts, 50-440 Hz, single phase DC: 127-173 Vdc		
Maximum Input Current:	Nominal Input Voltage	Module III Amperes	Module IIIA Amperes
	115 Vac	4.0	5.5
	150 Vdc	1.9	3.2
Recommended Fuse, @ Nominal Input Voltage:		6	8
Output Ratings:			
Efficiency	To 75%		
Voltage Regulation	0.05% (combined line and load)		
Ripple, RMS	3 mV maximum (10 mV on 3.5/5-volt models)*		
Ripple, P-P	50 mV maximum (typically 30 mV)		
Temp. Coefficient	0.01% per °C		
Turn-ON/OFF overshoot	None (output voltage)		
Transient Response	1.0 millisecond for half-load change/return to 1% band		
Remote Programming	1000 ohms per volt (resistance)/1V:1V (signal)		
Output Impedance:	Typically less than 0.005 ohm @ 10 kHz 0.01 ohm @ 50 kHz 0.015 ohm @ 100 kHz 0.02 ohm @ 500 kHz		
Current Limit:	Automatic, internally adjustable to 40% to 125% of 40°C full load current. (Consult factory for requirements greater than 125%.) Factory-set to approximately 110% of rated (40°C) current. See individual unit specification.		
Over-voltage (OVP) Limit:	Automatic, adjustable crowbar action, self-contained. Factory-set at 1V or 10% of nominal output voltage. (See unit specifications.) Reset requires cycling input power. (Allow 30 seconds for discharge of input capacitors.) OVP action is delayed (typically) by approximately 100 microseconds to avoid nuisance tripping. Resolution of OVP adjust 0.1% of output voltage rating (typical). OVP stability 2% of voltage trip setting for all conditions (typical).		
EMI (RFI):	Designed to meet most portions of MIL-STD-461A.		
Stability:	After one hour warm-up, 0.05% for 24 hours with all external effects held constant.		
Resolution:	0.05% of output voltage maximum. (See individual unit specifications.)		
Parallel Operation:	Consult factory for Application Note PAN-STM-1		
Series Operation:	To 200 Vdc maximum.		
Remote Sensing:	The voltage drop per load lead is constrained only by the maximum rated unit output voltage. (For example, 5-volt nominal STM supplies have an E_o maximum of 6.0 volts. Thus, operating at an output of 5 volts allows a total of 1 volt total lead drop, or 0.5 volt per load lead.)		
Ambient Rating:	0 to 71°C/32 to 160°F. (See current ratings in unit specifications.)		
Cooling:	Natural convection.		
Dimensions (inches) - (mm):		Module III	Module IIIA
Width		5-1/8 (130)	5-1/8 (130)
Height		3-5/16 (84)	3-5/16 (84)
Depth		9-1/2 (241)	14 (356)
Weight (lbs) - (kg):		6-1/2 (3)	9 (4)
Volume (cu. in.)-(cu.m):		160 (2.62)	238 (3.9)
Input-Output Connections:	All connections are made to a 7-terminal barrier strip using #5-40 screws.		

Note: Specifications valid at 50/60Hz. At higher input frequencies, ripple may be greater.

Table 1-1B Unit Specifications Module III

Model No.	3.5-24	5-24	9-12	12-12	15-10	18-10	24-8.5	28-7	36-4	48-4
Output Ratings (dc):										
Nominal Voltage (V)	3.5	5.0	9.0	12.0	15.0	18.0	24.0	28.0	36.0	48.0
Voltage Range (V)	3.0-4.5	4.5-6.0	6-10	9.5-13.5	13-17	16-20	19-25	24-30	29-43	42-56
Regulation (mV)	1.75	2.5	4.5	6.0	7.5	9.0	12.0	14.0	18.0	24.0
Current (A);										
@ 40°C	24.0	24.0	12.0	12.0	10.0	10.0	8.5	7.0	4.0	4.0
@ 50°C	19.4	19.4	9.7	9.7	8.1	8.1	6.8	5.6	3.2	3.2
@ 60°C	14.9	14.9	7.5	7.5	6.2	6.2	5.3	4.3	2.5	2.5
@ 71°C	9.6	9.6	4.8	4.8	4.0	4.0	3.4	2.8	1.6	1.6
Current Limit (Adc) Factory set to;	26.4	26.4	13.2	13.2	11.0	11.0	9.3	7.7	4.4	4.4
Over-voltage Limit (Vdc) Factory set to;	4.5	6.0	10.0	13.2	16.3	19.8	26.4	30.8	39.6	52.8
Input Ratings (Typ.) Efficiency (%)	60	64	66	70	68	72	73	73	71	75
Output Adjust Resolution (mV)	2.25	3.0	5.0	6.75	8.5	10.0	12.5	15.0	21.5	28.0

Table 1-1C Unit Specifications Module IIIA

Model No.	3.5-36	5-36	9-20	12-20	15-15	18-15	24-13	28-11	36-6	48-6
Output Ratings (dc):										
Nominal Voltage (V)	3.5	5.0	9.0	12.0	15.0	18.0	24.0	28.0	36.0	48.0
Voltage Range (V)	3.0-4.5	4.5-6.0	6-10	9.5-13.5	13-17	16-20	19-25	24-30	29-43	42-56
Regulation (mV)	1.75	2.5	4.5	6.0	7.5	9.0	12.0	14.0	18.0	24.0
Current (A);										
@ 40°C	36.0	36.0	20.0	20.0	15.0	15.0	13.0	11.0	6.0	6.0
@ 50°C	29.1	29.1	16.2	16.2	12.1	12.1	10.5	8.9	4.8	4.8
@ 60°C	22.3	22.3	12.4	12.4	9.3	9.3	8.0	6.8	3.7	3.7
@ 71°C	14.4	14.4	8.0	8.0	6.0	6.0	5.2	4.4	2.4	2.4
Current Limit (Adc) Factory set to;	39.6	39.6	22.0	22.0	16.5	16.5	14.3	12.1	6.6	6.6
Over-voltage Limit (Vdc) Factory set to;	4.5	6.0	10.0	13.2	16.3	19.8	26.4	30.8	39.6	52.8
Input Ratings (Typ.) Efficiency (%)	60	64	66	70	68	72	73	73	71	75
Output Adjust Resolution (mV)	2.25	3.0	5.0	6.25	8.5	10.0	12.5	15.0	21.5	28.0

2 INSTALLATION

2.1 GENERAL

After unpacking, general inspection and preliminary check-out procedures should be performed to assure that the unit is in proper working order. If it is determined that the unit has been damaged, the carrier should be notified immediately. Repair problems may be directed to the nearest Sorensen representative, or to the Service Department, Sorensen Company, Manchester New Hampshire.

2.2 INSPECTION

Check for damage incurred during shipment as follows:

1. Inspect enclosures for dents, chips and other obvious signs of damage.
2. Check condition of external terminal board. Make certain that all terminal screws are in place and that links are fitted over the barrier strips between terminals 1 and 2, and between 3 and 4.
3. Inspect fuse holders for evidence of damage.
4. If internal damage is suspected.
   a. Remove all flat-head retaining screws from around the perimeters of the case assembly.

NOTE

For Module IIIA units, it is only necessary to remove the top (and one side) of the casing.

   b. Remove the round-head screws from the rear panel and remove the case.
   c. Inspect the components and printed circuit board (PCB) for damage.
5. Check that the power transistors are firmly plugged into their sockets. These are readily removable for servicing.

2.3 INPUT CONNECTIONS

STM units are shipped ready for use with either 115 Vac or 150 Vdc.

NOTE

For either connection, fuse F1 is in series with the input line connected to TB1 pin 7. Maximum circuit protection is provided when the high side of the input line (the black wire in standard ac connections) is connected to this pin.

2.4 ELECTRICAL CHECK

CAUTION

Before applying power to the unit, it is important that input/output isolation be checked. This may be done using a VOM set to the x 10 K scale. Assure maximum resistance from input at TB1-6 and -7 to case (ground), and output at TB2-1 to case. It is recommended that this measurement be performed each time the unit case is removed and replaced.

To perform an initial electrical check, proceed as follows:

1. Make certain that unit is located in an area where free passage of air is unrestricted. Connect input leads to terminals TB1-6 and -7 (IN). Use terminal 5 (GRD) for input system ground.
2. Connect a dc voltmeter across terminals TP1-1 and -4 (OUTPUT SENSING). Select a voltage range compatible with rated output.
3. Apply nominal rated input power.
4. Rotate output adjust sufficiently to swing the dc voltmeter from minimum rated voltage to nominal output voltage per Table 1-1. (Adjustment to 1 volt or 10% higher than nominal output will trip the OVP.)
5. Set output voltage at its nominal value and remove input power.

2.5 MOUNTING

STM units may be mounted in a variety of positions and locations, including rack mounting.

NOTE

Specific data for rack mounts is avail-

able at the factory. Figure 2-1 is an overall outline drawing of the STM modules.

1. Cantilever-type mounting: From a vertical panel or wall (where vertical airflow is unrestricted):

   a. End mounting - Use knockout per Figure 2-2. This knockout clears the terminal block and fuses.

   b. Side or bottom mounting - No knockout is required. Use the four mounting holes shown in Figure 2-2.

2. Flat Mounting: On a horizontal surface (no vertical airflow);

   a. End mounting: Not recommended.

   b. Side mounting: Module III units; use knockout per Figure 2-2. Module IIIA units; mount directly with no knockout required.

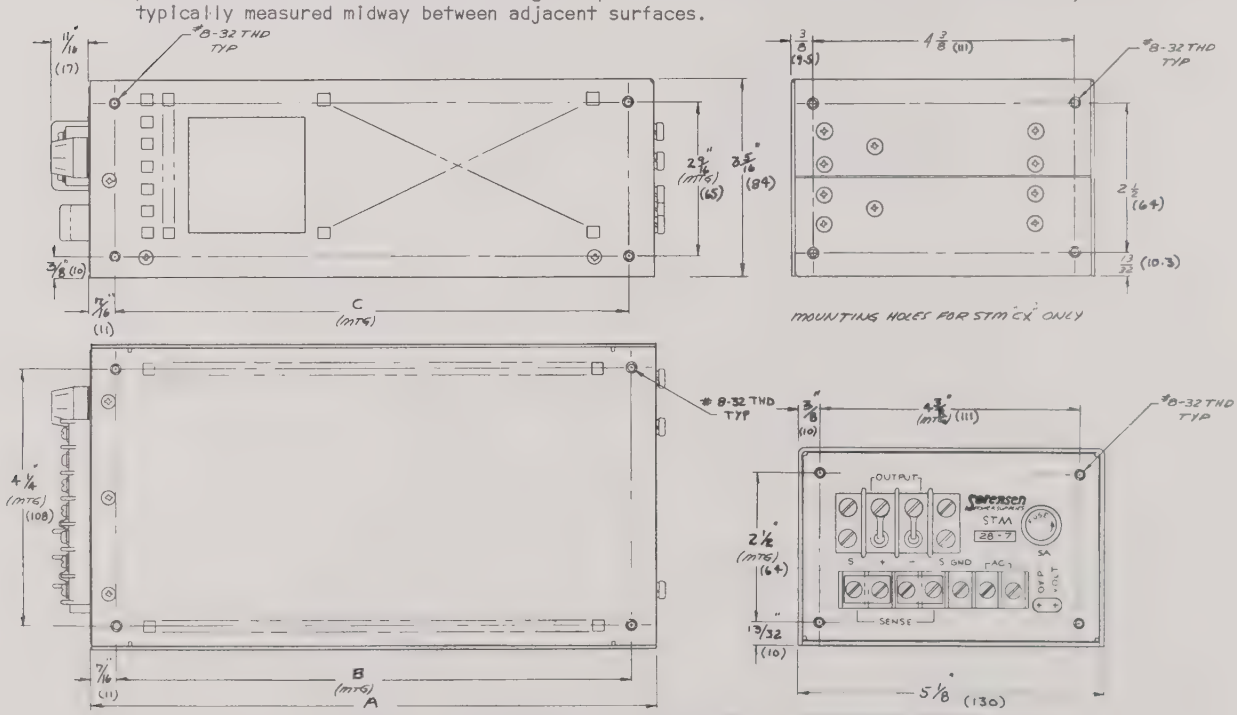
   c. Bottom mounting: Use knockout per Figure 2-2.

NOTES

a. Vertical mounting per paragraphs 1.a and 1.b preceding are preferred since maximum airflow is assured.

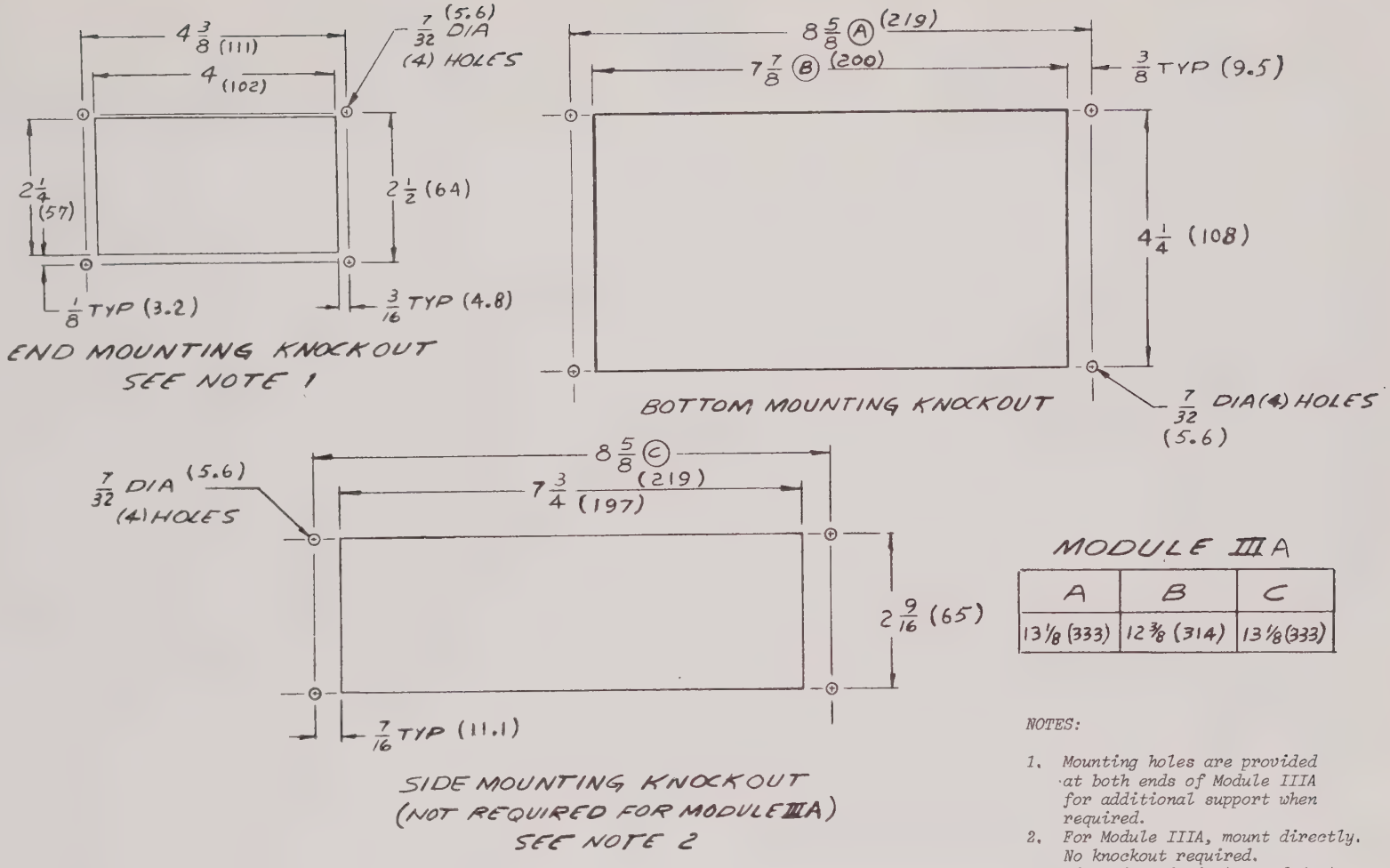
b. Mounting screws should be No. 8-32 and just long enough to penetrate 1/4 inch into the STM unit and through the mounting surface with lock/flat washers used.

During installation, if two or more supplies are to be rack-mounted or otherwise stacked, the operating ambient of the upper units will be affected (not to exceed 71°C/160°F). Output current must be derated according to specifications for ambients above 40°C/104°F, typically measured midway between adjacent surfaces.



UNIT	DIMENSION A	DIMENSION B	DIMENSION C
STM III	9-1/2" (241)	8-5/8" (219)	8-5/8" (219)
STM IIIA	14.0" (356)	13-1/8" (333)	13-1/8" (333)

Figure 2-1
Outline Drawing, STM Modules III and IIIA



MODULE IIIA

A	B	C
13 1/8 (333)	12 3/8 (314)	13 1/8 (333)

NOTES:

1. *Mounting holes are provided at both ends of Module IIIA for additional support when required.*
2. *For Module IIIA, mount directly. No knockout required.*
3. *Dimensions in inches and (mm).*

Figure 2-2 Knockout Dimensions, STM Modules III and IIIA

3 OPERATION

3.1 GENERAL

This section contains instructions on how to adapt the unit to, and operate it in, a number of varied applications. These include remote sensing, remote programming, and series operation.

CAUTION

1. *The sensing and power circuits form a closed loop. Opening this loop, either by removing a terminal board link or disconnecting a sensing or programming lead will result in a high unit output and will cause the OVP crowbar to operate.*

3.2 CONTROLS

STM units are equipped with two controls; the output adjust and the OVP adjust potentiometers. The output adjust control R26 is used to vary the output voltage while the OVP adjust control R14 is used to vary the OVP trip point. Both are factory-set to nominal values (see Table 1-1).

3.3 PRE-OPERATION CONSIDERATIONS

3.3.1 Current Limiting Setting

The current-limiting point is factory-set to approximately 110% of rated 40°C current*. This limit will vary inversely with input line changes. For ambients beyond 40°C, rated output current is derated per Table 1-1, and the limit setting should be reset accordingly. To avoid current limiting due to line and/or temperature variations, unit operating current should be 15% of rated current below the limit setting.

3.3.2 Current Limit Reset

To reset the current limit proceed as follows:

1. Rotate limit adjust control R52 on A100 printed circuit board (PCB) fully clockwise (CW).
2. Connect a voltmeter across output terminals TB1-1 and -4. Apply nominal input power and adjust output voltage control (R26) for the unit's rated nominal value.
3. Remove input power and connect an ammeter and variable load resistor in series across the output terminals.
4. Reapply input power and adjust load so that the test ammeter indicates current limit determined in paragraph 3.3.1.
5. Rotate R52 on the A100 PCB slowly counterclockwise (CCW) until both output voltage and current begin to drop.
6. Remove input power, disconnect test instruments and load. Replace top cover.

3.3.3 Over-Voltage Trip Point

The OVP trip point is factory set to 1V or 10% (whichever is greater) higher than the rated nominal output voltage (Table 1-1). However, if the output voltage will be operated near its maximum rating, it may be desired to raise the trip point. For nuisance-free OVP, the trip point should be maintained at least 1V or 10% (whichever is greater) above the operating voltage. For example, a 5V model operating at 5.5V should use a 6.5V trip setting.

3.3.4 OVP Trip Point Reset

To reset the OVP, proceed as follows:

1. Rotate OVP control (R14) on panel fully CW.
2. Rotate output control (R26) on panel until the output voltage is equal to the desired trip point.
3. Rotate OVP control R14 slowly CCW until the output voltage suddenly drops to zero. This indicates OVP has triggered the crowbar.
4. Remove the input power. Rotate output control CCW. Allow approximately 5 seconds for unit to discharge.
5. Apply input power. Reset output until desired operating voltage is obtained.

NOTE

The OVP circuit includes a time-delay network such that the over-voltage (OV) condition must exist for approximately 100 microseconds before the OVP fires. This delay prevents short-duration OV pulses from triggering the crowbar.

*Consult factory to set current limit beyond 125% of maximum rated output.

3.3.5 Reset After OVP Fires

If the OVP fires, proceed to reset the circuit as follows:

1. Remove input power and disconnect load (in case OV condition is externally induced). Allow approximately 5 seconds for unit to discharge.

2. Rotate output adjust R26 fully CCW (minimum voltage).

3. Apply input power and raise output voltage to desired value.

NOTE

If the OVP again trips, internal failure is indicated, or the output is set too close to operating voltage (see 3.3.4 preceding).

3.4 LOCAL SENSING

The unit is shipped ready for use in the local-sensing mode. In this mode, regulation is at the output terminals, not at the load. If variations in load-line voltage drops are expected to be prohibitive, refer to paragraph 3.5, remote sensing.

To operate the unit, proceed as follows:

1. Connect a voltmeter across output sense terminals TB1-1 (+) and TB1-4 (-).

2. Attach the input leads to terminals TB1-6 and -7. Use terminal 5 (GND) to ground input system.

3. Apply nominal input power.

4. Rotate output adjust until desired output voltage is indicated on voltmeter.

5. Remove input power, disconnect voltmeter and connect load leads to terminals TB2-1 and -2. Do not remove or loosen any of the interconnecting links. Apply nominal input. Unit supplies highly regulated power to load.

WARNING

Do not touch enclosure while unit is operating under load. Surface temperature is comparatively high. If unit must be handled immediately after operation, wear heat-resistant gloves.

3.5 REMOTE SENSING

If it is desirable to sense (regulate) unit output at the load rather than at output terminals, remove the links between terminals TB1-1 and -2, and TB1-3 and -4. Run a sensing lead from terminal TB1-1 to the positive side of load; connect the other lead from terminal TB1-4 to the negative side of load (see Figure 3-1). Sensing leads should be fabricated using a shielded, twisted pair of wires. Set unit in operation per paragraph 3.4. Do not exceed maximum rated output.

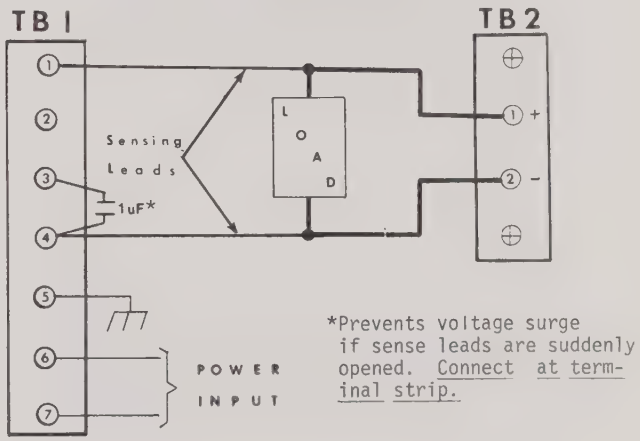


Figure 3-1
Remote Sensing Connections

3.6 REMOTE PROGRAMMING

The unit may be programmed to supply pre-determined output voltages by inserting a calculated resistance into the voltage-sensing circuit. Programming sensitivity is approximately 1000-ohms-per volt; that is 1000 ohms are required for each volt difference between the desired output and the minimum value of the unit's specified range. The program resistor should be a 1/8-watt (or larger) precision film resistor with a 25 PPM/^{o}C coefficient (equal to MIL style RN55E). The programming current is approximately 1 milliampere. However, a 1.0 uF capacitor in parallel with the inserted programming resistor is required to prevent the unit from oscillation.

To adapt the unit for remote programming, proceed as follows:

1. With normal local sensing (paragraph 3.4), set power to ON and adjust output to specified rated minimum output voltage (see Table 1-1 for specific model). For example, for a 12V module, set the output to 9.5 volts.

2. At this point, any value within rated output range (Table 1-1) can be obtained by inserting 1000 ohms-per-volt difference between the desired voltage and the minimum voltage. For example, to obtain 12.0-volt output in the above example, the difference is 12.0 (-) 9.5 or 2.5 volts. The program resistor should be 2.5 x 1000 or 2.5K ohms.

3. Parallel the program resistor with a 1.0 uF capacitor.

4. Set power to OFF. Remove the link from TB1-3 and -4 and connect programming resistor in its place. Note that either local or remote sense can be used.

5. Apply input power and verify load voltage across terminals TB2-1 and -2 as the desired value (using local sense).

3.7 SERIES OPERATION

Series operation is utilized for the purpose of obtaining a higher output voltage than available from a single model. Two supplies may be connected in series to form a dual polarity (+) & (-) output system such as (±) 12V with a common return. Any amount of bridging load may be tolerated.

3.8 PARALLEL OPERATION

Consult factory if it is desired to operate STM units in parallel.

4. THEORY OF OPERATION

4.1 BASIC STM PRINCIPLES (Refer to Figure 4-1; Block Diagram)

STM circuitry incorporated 20kHz switching techniques, which contributes to the high efficiency and exceptional power density (high power output capability and small physical size) of the unit.

The basic circuit consists of a 20kHz push-pull, pulse width modulated inverter operating directly from the rectified AC line. The inverter output is rectified and filtered in a double L-C filter, and the resultant dc output voltage is sensed and compared with a reference voltage. Any difference, or error voltage is amplified and feed back to the inverter to control the pulse width. Thus a closed loop is achieved, resulting in excellent line/load regulation.

4.2 CIRCUIT DESCRIPTION

4.2.1 Input Circuits: (Refer to schematic diagram, Figures 5-2/5-3)

Input power is full wave rectified through diode bridge CR1 (or CR1-CR4 as applicable) and filtered by C1 and C2. Approximately 150 Vdc (depending on the input line variations) appears across capacitor C2, on which is superimposed a 120 Hz component (twice the line frequency). This dc voltage establishes the operating level of push-pull inverter T1/Q3/Q4, and through pre-regulator A200, a regulated 110 Vdc input for bias inverter T1/Q1/Q2 on printed circuit board A100 (reference Figure 5-6B).

4.2.2 CLOCK MULTIVIBRATOR

When the regulated 110 Vdc bias is applied to the A100 board, the master clock begins to oscillate at 20kHz (just half the ramp frequency). The master clock consists of two cross coupled comparators U1. The output of the clock (pins 13 and 14 of U1) is buffered and level shifted by the other two comparators contained in U1. The buffered clock output from pins 1 and 2 of U1 is used to drive the bases of Q1 and Q2 which comprise the push-pull bias inverter. The bias transformer T1 is used to provide bias and base drive voltages. The three separate secondaries function as follows:

1. Pins 4-6; develop bias voltages for the ramp generator, comparator, and current limiter A100Q5 and associated circuitry.

2. Pins 7-9; supply base drive current for main switching transistors Q3 and Q4 through Q1 and Q2 on the chassis assembly.

3. Pins 10-12; provide bias for reference and error amplifier circuitry (A100) IC2, IC4 and associated components.

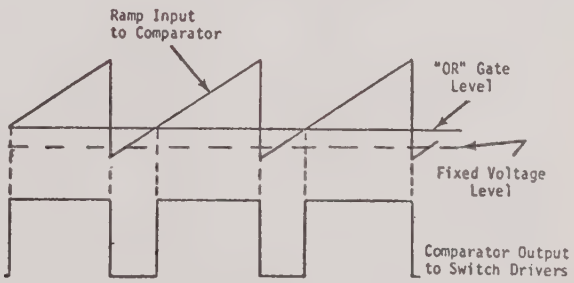
4.2.3 RAMP GENERATION CIRCUIT

A ramp sync signal of 40kHz (twice the clock frequency) generated by the nonbuffered clock output of U1 (pins 13 and 14) is sent to pin 5 of the ramp reset comparator (U3, pins 2, 4, and 5). A constant current source made up of U2, pins 1, 2, and 3, VR6 and Q7 charges C11. The voltage on C11 ramps up linearly with time until C11 is discharged by the ramp reset comparator U3 (pins 2, 4, and 5).

4.2.4 PLUS 10 VOLT DETECT AND SOFT START CIRCUIT

A comparator comprised of U3, pins 10, 11, and 13 is used to detect the +10V bias supply. When the +10 volt bias supply drops below 8.2 volts the output at U3 pin 13 is high (10V). This turns on Q8, forcing the unit into full current limit. When the voltage exceeds 8.2 volts, the output at U3 pin 13 goes low (ØV) turning off Q8. When Q8 is off, C22 discharges across R55 and as the voltage decays, the unit is soft started. This soft start feature eliminates high stress levels in the main inverter switch transistors. During turn-off, the main switching transistors are shut off when the 10 volt bias supply drops below 8.8 volts. This protects the main power handling components from high stress levels associated with turn-off.

The comparator duty cycle function is illustrated in the following diagram:



4.2.5 Switching Transistors

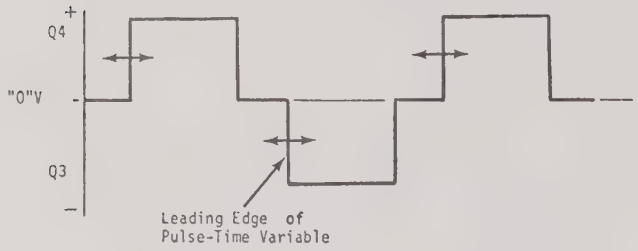
Switching transistors Q3 and Q4 react to the output of the comparator through their respective drivers Q1 and Q2. This input rectangular wave, with a 40kHz repetition rate is fed simultaneously to the bases of Q1 and Q2. Only one will be activated, however, as the collectors of each are connected to secondary 7, 8, and 9 of bias transformer A100T1. Thus, while one is turned ON (+5 volts), the other will be at cut-off (-5 volts). Since the transformer waveform is 20kHz, synchronized with the comparator, altenate comparator outputs are fed to Q1/Q2.

The comparator thus turns on the appropriate drive transistor, which in turn activates switching transistors Q3 or Q4. Turn-off of Q3

and Q4 is accomplished by diodes CR5 and CR10 in conjunction with bias transformer A100T1. This action results in very rapid turn-off of the switching transistors.

4.2.6 Output Circuits (Figures 5-2/5-3)

The switching action of Q3/Q4 results in the following string of pulses at the primary of transformer T1: (pulse width determined by ramp vs. OR gate output).



At the secondary, rectification takes place through CR11 (and CR19/20 where used). The resultant signal at a 40kHz repetition rate, is then filtered by L4/C9, and L5/C10, and appears as the supply output voltage at TB2-1 (+) and TB2-2 (-). The integration function of the filtering reduces the 40kHz component of the output to less than 3 millivolts.

4.2.7 Current Limit Circuit

The current limit circuit protects the unit in the event of an excessive current demand such as a short circuit. By design, a fixed relationship exists between the output current of the unit, and the peak current of switching transistors Q3 and Q4, located on the main chassis. By controlling the peak current of Q3 and Q4, therefore, the ouptut current may be controlled.

The switched current is sensed by R5, which is located on the main PC board, and applied to the A100 board through P1-12. This sensed current is amplified by U6 and applied to peak detector C22 through CR19. The resultant peak DC voltage is then applied to the control amplifier (U2, pins 12, 13, and 14) through CR18. CR18 and CR19 act as a temperature compensating pair, adding thermal stability to the circuit. The output of the control amplifier is applied to the "OR for highs" line through CR17. When the "Peak" DC voltage on U2 pin 12 is equal to, or greater than, the level set by the current limit adjustment R52, the unit will be operating in the current mode. The "OR-point" voltage (CR17 cathode) is applied to the duty cycle comparator (U3, pins 1, 6, and 7) where it is compared to the ramp signal. Thus the duty cycle is controlled, producing whatever voltage is necessary to restrict the output current.

4.2.8 Voltage Control Amplifier

The voltage regulating circuits obtain the isolated bias voltages from T1 secondary, pins 10, 11, and 12. VR3 and VR4 zener diodes act as regulators for the bias voltage - VR5 is the primary voltage reference diode for the supply. The anode of VR5 is connected to the unit positive sense terminal TB1-1 through L7-A which is located on the main PCB.

When the supply is operating normally in a stable condition, terminals 2 and 3 of error amplifier U4 will be at 6.2 volts. The 6.2 volts applied across R32 and R33 is used to derive the 1 milliamp sense current with R32 being used to set the sense loop current to exactly 1 milliamp. Since the current flowing through R25 and R26 (located on the main PCB) is always equal and opposite the output voltage U4 pins 2 and 3 are kept at 6.2 volts. The output of U4 (pin 6) is buffered by an emitter follower, Q4, which drives opto-isolator Q5 providing the isolated feedback path for the output voltage control signal. The output of the opto-isolator is wired into the "OR for highs" point. This feeds the duty cycle comparator (U3, pins 1, 6, and 7) which compares the control voltage with the ramp voltage and controls to satisfy the voltage error amplifier U4.

A negative feedback loop is formed, consisting of: error amplifier, isolator, OR gate, comparator, switching transistors, T1 (main chassis), and output rectifiers and filters. Compensation is provided in the negative sensing circuit by C18/R24 together with (A100) C13/R31 to ensure that the loop remains free of oscillations.

4.2.9 Inverter Base Drive

The output of the duty cycle comparator (U3, pin 1) controls the operation of Q5 and Q6. When the output of the comparator is low, both Q5 and Q6 will be ON, providing base drive to the 2N2219A inverter drivers. Only one of the 2N2219A (Q1, or Q2 located on the main PCB in module III units) or one pair of 2N2219A (Q1A/Q1B or Q2A/Q2B located on the base drive PCB in module IIIA units) will be providing drive to the main chassis inverter transistors Q3/Q4. This is due to the fact that the base drive windings of T1 (pins 7, 8, and 9) will be positively phased for turning on Q3 or Q4, but not both. (See para. 4.2.6)

4.2.10 2.5 Volt Reference

A 2.5 volt reference voltage is locally generated on the A100 board by a resistive divider consisting of R15, R16, and R17. R16 is used to adjust the voltage which is then applied to the + input of voltage follower U2 (pins 8, 9, and 10) which buffers the signal for use in the clock, ramp reset, OVP, +10V detect and soft start circuits.

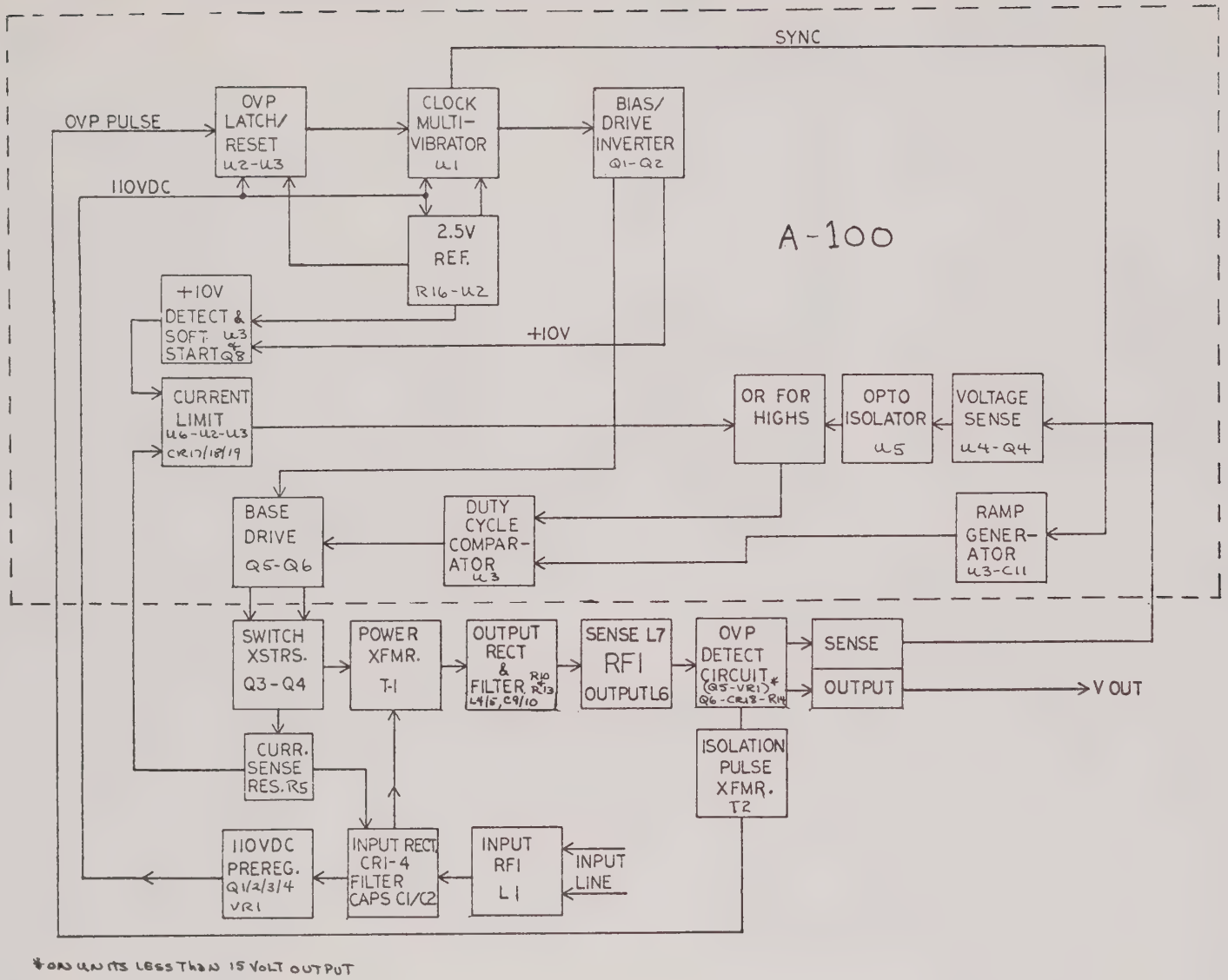


Figure 4-1
STM SIMPLIFIED BLOCK DIAGRAM

4.2.11 Overvoltage Protection Shutdown and Reset

The OVP circuit senses an overvoltage condition at the output terminals, and acts to fire Q6 (located on the main PCB), momentarily shorting the output voltage. Either of two circuit designs are used, depending on the level of output voltage. Both are analyzed in the following paragraphs.

4.2.11.1 Supply Outputs to 12 Volts

For these lower voltage supplies, regulator VR1 establishes the overvoltage reference level. It's bias is set by C8/CR12, CR13/CR14, and Q5. A sample of this reference appears across potentiometer R14, and is presented through temperature compensating diodes CR15/16 to the gate of programmable unijunction transistor (PUT) Q6. Also present at the anode of Q6 is a sample of the output voltage. When this sample exceeds the reference sample at the gate of Q6 by more than 300mV, approximately, Q6 fires sending a current pulse through transformer T-2, also located on the main PCB. At the same time, an isolated voltage pulse is sent from T-2 to the A-100 card. This pulse causes the OVP latch (U3, pins 8, 9, and 14) to latch with pin 14 at about 5 volts. The high latch output turns Q3 ON, which disables the clock buffer. When the clock buffer is disabled, the main inverter (Q3/Q4 and T1), located on the chassis and main PCB, are shut down. The unit will remain in the shut down mode until the input line is recycled. When the input line is recycled, the OVP reset op-amp (U2, pins 5, 6, and 7) provides a clear pulse to the latch clearing any previously set condition.

4.2.11.2 Supply Outputs of 15 Volts and Greater

For STM output voltages of 15 volts or greater, Q6 is a silicon unilateral switch (SUS), used as a triggering device. This device utilizes an internal voltage as the overvoltage reference. When Q6 anode/cathode voltage exceeds this level (approximately 7.5 Vdc), it fires, abruptly reducing its voltage. Unit shutdown then occurs through the T2/A100/CR1 action described in paragraph 4.2.12.1.

4.2.12 Radio Frequency Interference (RFI) Control

The switching action of this type of supply might be expected to create a source of RFI. The design of the STM series has minimized this interference, using the limits specified in MIL-STD461A as a reference.

Conducted interference on the input lines is reduced to acceptable levels by L1/L2/L3 together with C3/C4 on the main chassis. Conducted interference at the output load and sense leads is minimized by L6/L7 and C13/C14. Radiated interference is effectively minimized by the metal enclosure of the STM series power supplies.

5 SERVICE AND REPAIR

5.1 GENERAL

This section provides unit troubleshooting data, and calibration and performance-testing procedures. The troubleshooting data should be used in conjunction with the schematic diagrams (Figures 5-2/5-3), location photos (Figures 5-4/5-5), and previous Section 4 which outlines the theory of operation. Questions pertaining to repair should be directed to the nearest Sorensen service representative or to the Service Dept., Sorensen Company, 676 Island Pond Road, Manchester, N.H. 03103. Include the model and serial numbers in any correspondence. Should it be necessary to return a unit to the factory for repair, authorization from the Sorensen service dept. must first be obtained. Sorensen Company will not assume responsibility for units returned without prior authorization.

Unit troubleshooting hints are provided in Tables 5-1 and 5-2 in the form of SYMPTOM/PROBABLE CAUSE/REMEDY. Where practicable, step-by-step procedures are used to facilitate isolation of a problem area.

Care should be taken when replacing any component, even if it appears obviously defective. A failed component is generally the result of a malfunction elsewhere in the system. It is the purpose of this troubleshooting procedure to help isolate both the failed component and the cause of its failure.

5.2 PERIODIC SERVICING

The STM models require no periodic servicing. However, when a unit is taken off the line it is recommended that the enclosure be inspected and cleaned of any accumulations of dust or other debris which could impede the free flow of air through the unit.

5.3 TEST EQUIPMENT REQUIRED

Use the test equipment listed (or an equivalent)

1. Oscilloscope, dual trace, 20-MHz bandwidth, isolated from ground. (Tektronix 454 with 10X voltage probe for channel A.)

2. 50-ohm, 2-watt load (in series with channel B and current probe);

   Channel B; current probe (Tektronix P6042)

3. Differential voltmeter (Fluke 845)

4. Differential voltage probe (Tektronix P6046)

5. RMS voltmeter (Hewlett Packard HP-3400A)

6. VOM (Simpson 260)

CAUTION

1. *Assure that all test equipment used while troubleshooting is NOT GROUNDED. Use an isolation transformer wherever practicable.*

2. *Each time the unit is opened, re-check for input and output isolation to case ground before turn-on.*

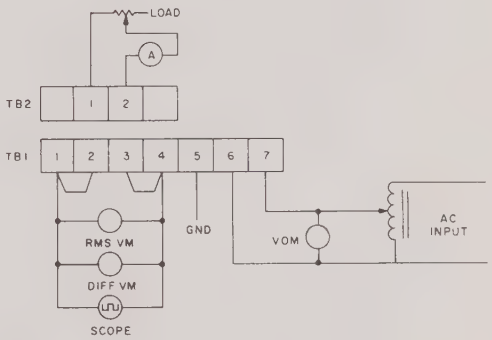


Figure 5-1
Test Equipment Setup

5.4 TROUBLESHOOTING

5.4.1 General Considerations

Before attempting repairs, the STM unit should be carefully inspected for apparent defects, such as broken or damaged components/connectors or PCB, or for obvious heat damage or loose pin connections.

After replacing an electrical component, the simulated turn-on procedure outlined in paragraph 5.5.1 should be performed before placing the unit into service.

The physical size and shape of a replacement part can have an effect on the performance of the power supply. The part should therefore be a direct replacement whenever possible. Section 6 of this manual lists replaceable parts along with the Sorensen part numbers as applicable.

5.4.2 Switching Transistors (Q3/Q4)

CAUTION

The casings of these transistors are "live" during operation.

In the event power transistors Q3 and/or Q4, require replacement, the probable cause of failure should be determined before power is applied to the unit. Proceed as follows: (Use test equipment per paragraph 5-3).

1. Remove the case screws of both Q3 and Q4, isolating the collectors from the circuit.
2. With a VOM set to the R x 1 scale, measure an open circuit from Q4 emitter (-) to Transformer T1, black lead (+).
3. Check for line-to-chassis isolation. Read open circuit on VOM set to R x 10K scale.
4. With the VOM, check the drive circuit components for a possible short.

NOTE

After the cause of failure has been eliminated, proceed to simulated turn-on procedure (paragraph 5.5.1).

5.4.3 Over-Voltage Protection (OVP) Circuit

Failure in the OVP circuit can generally be traced to an improper adjustment of OVP potentiometer (R14), or one of the following:

1. For units up to 12-volts output; CR12, Q5, VR1, Q6, CR18, or an associated component, (Figure 5-2).
2. For units with 15-volts (or greater) output; Q6, CR18, or an associated component, (Figure 5-3).

After replacing any component in this section, the OVP should be properly set as outlined in final calibration procedure (paragraph 5.5.2). If OVP continues to actuate, proceed to PCB A100 troubleshooting in paragraph 5.4.4.

Table 5-1 Main Chassis Troubleshooting

SYMPTOM	PROBABLE CAUSE	REMEDY
1. No output	A. Over-voltage protection circuit tripped (fuse intact). *NOTE* *With a meter connected to the output, turn the unit on. If the meter jumps and then goes to zero, the OVP circuit has probably been actuated.*	1) Reapply input voltage after approximately 5 seconds. 2) Verify proper setting of OVP trip point (R14, accessible through front panel). CW adjustment increases the output voltage trip point. If this adjustment resolves the problem, reset R14 per paragraph 3.3.4 in Section 3 of this manual. 3) If OVP tripping recurs with normal output loading, or with no output, refer to OVP troubleshooting procedure (paragraph 5.4.3).
	B. Current limit improperly adjusted.	If, during unit calibration or repair, potentiometer R52 on PCB A100 has been left in the fully CCW position, no output will appear. Refer to final calibration procedure (paragraph 5.5.2).
	C. Output circuit shorted (fuse not affected).	Check individual output circuit components.
	D. Input fuse open.	1) Replace fuse. 2) For repetitive fuse failures, perform the following checks as necessary. a. Remove power and replace fuse. b. Connect a VOM (Simpson 260 or equivalent) set to the R x 1 scale between the transistor case (+) and emitter (-) of Q4 (Figures 5-2/5-3). A normal indication is an open circuit condition. If this occurs, continue to paragraph c. following. If a short is indicated (less than 15 ohms), remove the (Q3 and Q4) transistor case screws, which will isolate the collector(s) from the circuit. Repeat the resistance test for each transistor, collector to emitter. A short indicates a faulty transistor. Replace as necessary. *NOTE* *After replacing Q3/Q4, do not yet insert Q3/Q4 case screws until the probable cause of failure has been determined. Refer to Q3/Q4 troubleshooting, (paragraph 5.4.2).* c. Check for shorted input rectifier (CR1-CR4) as applicable. d. Check for short from input to chassis (TB1-6 or -7 to TB1-5). e. Connect the VOM across input terminals TB1-6 and -7. Remove the A100 control card. If the short is eliminated, proceed to the control PCB troubleshooting procedure (paragraph 5.4.4).

Table 5-1 Main Chassis Troubleshooting (cont'd)

SYMPTOM	PROBABLE CAUSE	REMEDY
1. No output (cont'd)	D. Input fuse open. (cont'd)	f. Check for continuity: (Refer to applicable schematic diagram, Figure 5-2/5-3). 1. Positive line output of rectifier CR1 (or CR1/CR2 cathodes as applicable) to; 2. Negative line output of rectifier CR1 (or CR3/CR4 anodes as applicable) to;
	E. Input circuit failure.	Remove case (collector) screws of transistors Q3 and Q4. Proceed to simulated turn-on procedure in paragraph 5.5.1.
2. High output	Improper setting of voltage adjust (R26) and OVP adjust (R14), accessible at front panel.	1) Reset R26 and R14 per paragraph 5.5.2 steps 6 through 11. 2) Check for continuity from J1-1 to TB1-4, and J1-2 to TB1-1. (See Tables 6-1 or 6-2 for proper resistance values.)
3. Low output	A. Current limit improperly adjusted.	Readjust per final turn-on procedure (paragraph 5.5.2).
4. Excessive ripple on output	A. Low line input. B. L5 & L6 defective. C. C10 malfunctioning or defective.	Monitor input line voltage. Visually inspect for signs of deterioration or damage. 1) Check for proper tightening of C10 hold-down screws. 2) Check C10 for short/open.
5. Poor regulation	A. Measuring across load terminals B. Unit overload. C. Current limit improperly adjusted. D. Control PCB A100. E. Faulty preregulator PCB A200.	Regulation must be measured across sensing terminals. Load not to exceed maximum rated current specification. Refer to adjustment procedure in paragraph 5.5.2. Check PCB per paragraph 5.4.4 Check for 110 Vdc output (Figure 5-8).

5.4.4 Control PCB A100

Select required test equipment from the recommended list in paragraph 5.3. Assure that any equipment used is not grounded. Refer to Figure 5-6 for schematic diagram and location of components. Proceed with troubleshooting as outlined in paragraph 5.4.4.1.

1. *Remove the switching transistor Q3/Q4 case (collector) screws before troubleshooting the control PCB.*

2. *After repair or replacement of PCB, continue to simulated turn-on procedure in paragraph 5.5.1.*

5.4.4.1 Control Board A100 Troubleshooting Areas to Check

1. Check 110 Vdc supply. This voltage enters the A-100 on P1-5 and P1-6. The 110 volt bias should measure 110 Vdc ± 5%. If this voltage is out of tolerance, check the pre-regulator PCB. Also check A-100 loading, maximum current draw should be 55 milliamperes.

2. Check the cathode of CR1 for 10 volts ±.3 volts. If no or low voltage is present, check Q1/Q2, T1, and the clock multivibrator U1. Also check for excessive current draw. (Warm or hot components).

3. If the clock multivibrator is not running, the OVP latch circuit may be holding it off. Check at U3 pin 14 for a low (0 volts). If pin 14 is high (approximately 5 volts) check OVP circuits (U3 and over-voltage detect circuits on main PCB).

4. The ramp input to the duty cycle comparator may be observed on pin 6 of U3. The ramp should look like the waveform in paragraph 4.2.4. If it does not, troubleshoot ramp reset and current source circuits.

5. Measure the voltage on CR16 cathode. This is the control "or for highs" point. This point should be low. (.5 volts or less). If it is not less than .5V and LED (CR15) is on, troubleshoot the voltage sense circuit. With CR15 off, the faulty signal is probably being generated by the current limit circuit. Troubleshoot the current limit circuit. If faulty operation still exists check opto-isolator U5.

6. Check the output of the duty cycle comparator U3 pin 1. Voltage should be approximately zero. If not, replace U3.

7. When all previous checks have been performed, check the base drive circuit. Connect current probe around the test link which is connected between E1 and E2 in the common emitter circuit of Q1/Q2. The alternate waveform peaks should be within 5 milliamperes of each other. If not, replace Q1 and Q2. If the balance is off by more than 5mA if will manifest itself in unit shutdown when hot, or by nonstarting after OVP shutdown when hot. *Note: this test should be performed when the unit is cold. (ie) near room temperature.*

8. POOR VOLTAGE MODE REGULATION

   Check voltage sense bias supply VR3 cathode. This reading should be 12.4 volts ± .6V. If not, replace VR3 and VR4. Check U4, U5, and Q4. At no load and at rated output voltage should measure 9.0 volts ± .2V at the A-100 board test points. Adjust R29 if any correction is needed. Replace VR5.

5.5.1 Simulated Turn-On Procedure

With the casing (collector) screws removed from transistors Q3/Q4 proceed as follows: (Use the test equipment outlined in paragraph 5.3).

1. With input power OFF, set the current limit control A100R52 fully CCW.

2. Connect the VOM, set to the R x 100 scale, positive lead to the primary terminal (black lead) of power transformer T1, negative lead to the Q3/Q4 emitter (yellow wire). Note the capacitor charge current.

3. Connect the VOM, set to the R x 1 scale, to the output terminals; positive to positive and negative to negative, and note the resistance. Meter will indicate a bleeder resistance according to the unit under test. (See parts list in Section 6 for resistance values.) Reverse the polarity of the VOM, Read forward biased diode in parallel with this resistance.

4. Connect the oscilloscope 10X probe positive lead to the base of the upper switching transistor (Q4), with the negative lead at the emitter. Set the oscilloscope sensitivity to 0.2V/division, timing to 20 usec/division and on the dc scale.

5. Clip the current probe to the common emitter lead of the switching transistors with the current direction (arrow) leaving the transistors into the main PCB. Set the oscilloscope sensitivity to 0.5A/division.

6. Momentarily apply, then quickly remove input power. Observe oscilloscope, and adjust as necessary for indication of a clean, square waveform on channel A. Repeat as necessary.

NOTE

Inability to obtain the waveform indicates a malfunction in the control PCB (refer to paragraph 5.4.4).

7. Place line power to ON. The unit should be working under deep current limiting mode. Check the following: (See waveform pattern "A", Figure 5-7).

   a. The oscillating square wave repetition should be from 45 to 55 microseconds.

   b. The peak level of the square waveform is at 0 volt, and the lower level is from (-) 4 to (-) 6.5 volts.

   c. No current will be detected by the current probe on channel B; only some very thin switching spikes of no significant magnitude should be evident.

8. Slowly adjust A100R52 CW. On the oscilloscope, the presence of a duty cycle will be observed. (See waveform patterns "B" and "C", Figure 5-7.) If A100R52 has no control over the duty cycle, check current limit circuit.

9. Check that the current waveform in pattern "C" has twice the repetition rate of the voltage waveform "B", and also note that current pulses are reasonably similar in amplitude. If both of these events are not as stated, check the transistor drive circuit components.

NOTE

The procedure to this point verifies the proper functioning of the input drive and power transistor circuits. Continue only when the conditions of steps 7, 8 and 9 have been satisfied.

10. Re-insert Q3/Q4 (collector) screws. Connect a VOM, set to the R x 10K scale, from Q3/Q4 case to chassis. Read open circuit.

5.5.2 Final Calibration

If the switching transistors and/or drive circuit components have been changed, perform tests per paragraph 5.5.1 before continuing.

1. Remove input power and connect test equipment as in steps 4 and 5 of previous paragraph 5.5.1.

2. Connect the dc differential voltmeter and rms voltmeter across the output sensing terminals (TB1-1 and -4).

3. On front panel, set the output voltage control (R26) to its approximate mid-range, and the OVP control R14 fully CW.

4. Remove load from output.

5. Set current limit adjust (A100) R52 fully CCW.

6. Apply nominal input power and turn A100R52 slowly CW. The output voltage should increase and the current waveform on oscilloscope channel B should appear as in pattern "D" of Figure 5-7.

NOTE

At this point, three phenomena should be carefully watched:

   a. If there is a short in the power transformer (T1) primary winding, the current waveform will have alternate duty cycle pulses missing when the unit is out of current limiting.

   b. If there is a short at the secondary winding or at the output, the current will appear excessive. Normally,

when the output is at no load the current observed on the oscilloscope should be no greater than 1.5 amperes.

c. Set 2.5 volt reference voltage with R16 and 9.0 volt reference with R29. (See A100 board schematic Figure 5-6B).

7. Apply full-rated load current. Set current limit control A100R52 at 115% or rated full-load current (per Table 1-1B/C).

8. Remove output load current. Set output voltage control R26 to 110% of rated output voltgage (per Table 1-1B/C).

9. Slowly turn OVP control R14 CCW until it shuts the unit off.

10. Turn R26 at least one full turn CCW, and remove input voltage. After one minute, re-apply input, and adjust R26 for rated output.

5.6 HI-POT TEST PROCEDURE

High potential test procedures have been carefully carried out at the factory. These units are 100% tested and should not require further testing in the field.

High potential tests can overstress or destroy the power semiconductors in this power supply if improperly applied.

Isolation measurements may be made using a standard VOM (Simpson 260 or equivalent) on the highest resistance scale available.

If it is essential to use the high potential test method, please contact the factory for information on special precautions that should be taken.

Sorensen Company cannot be held liable for any malfunctions resulting from the application of a high potential test (greater thatn 100V). See standard Sorensen Company warranty.

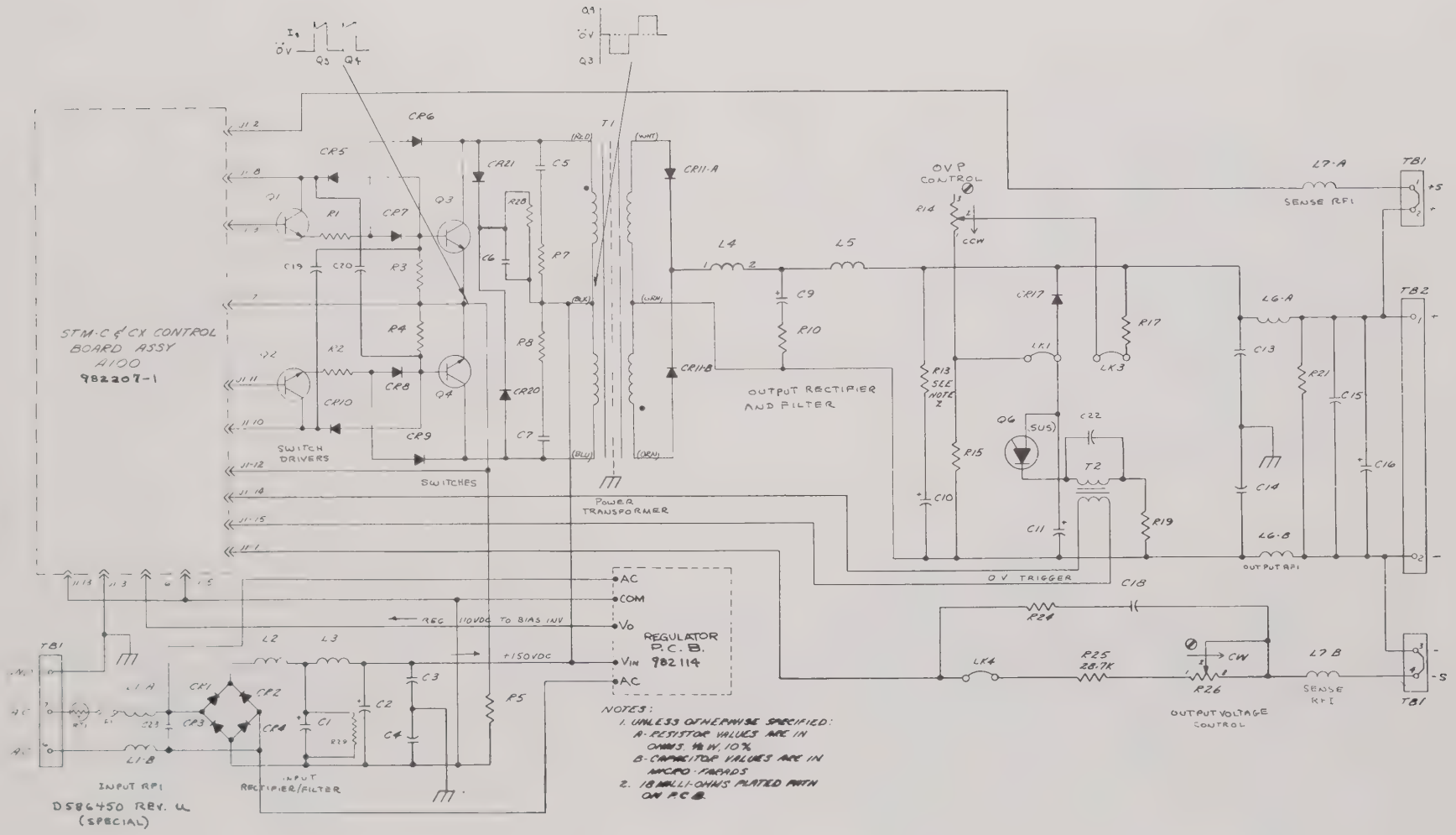
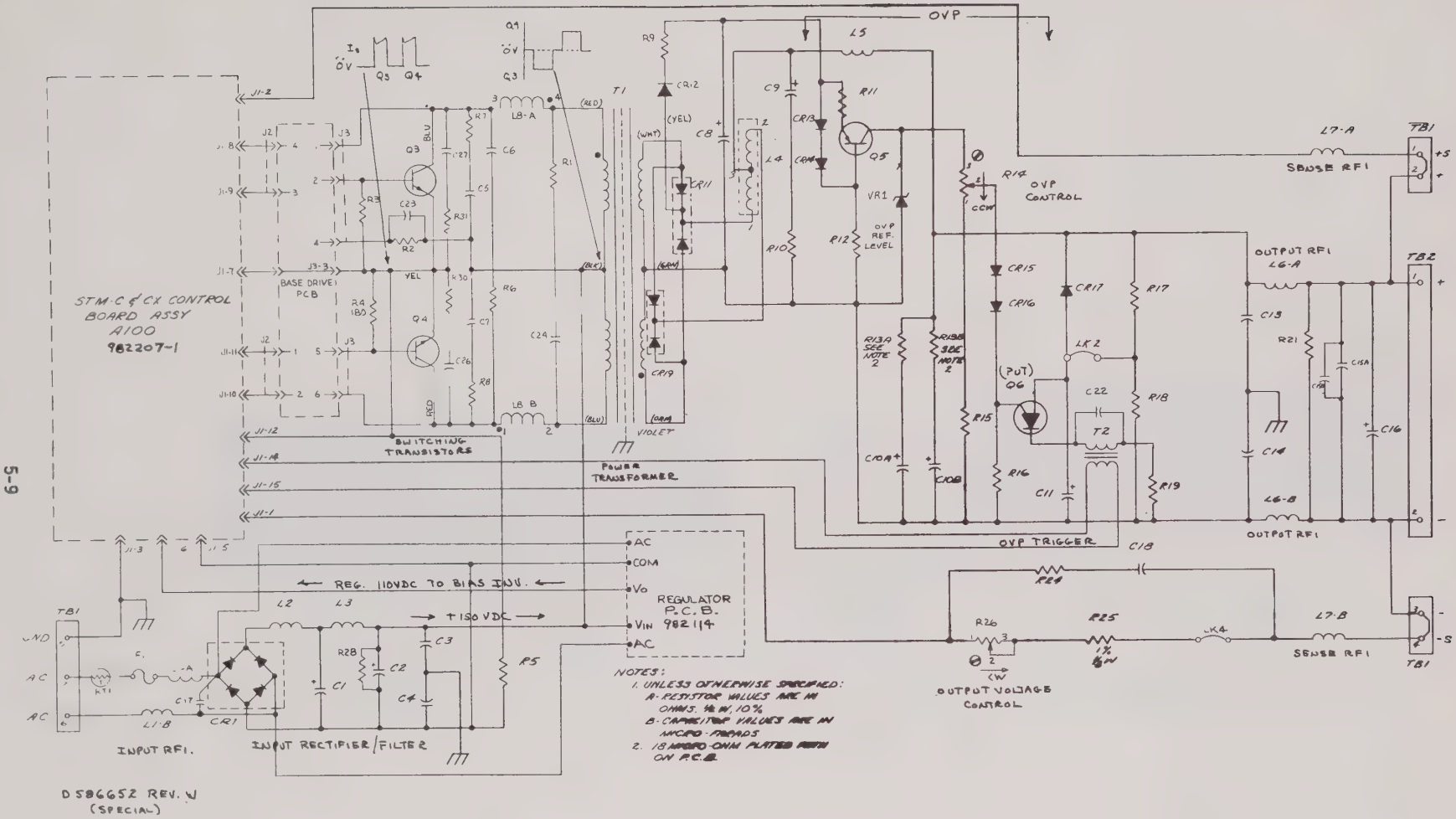


Figure 5-2
STM 15-48 Volt Units
Typical Schematic Diagram
(Module III Shown)



5-9

FIGURE 5-3
STM 3-12 VOLT UNITS
TYPICAL SCHEMATIC DIAGRAM
(MODULE 111A SHOWN)

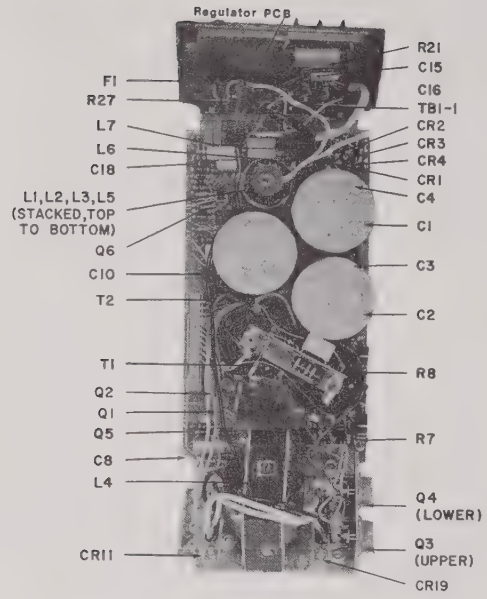


Figure 5-4 Module III-Typical Component Location Pho

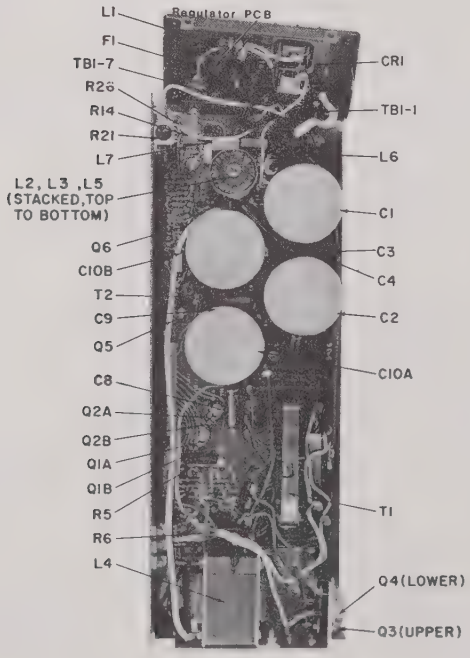
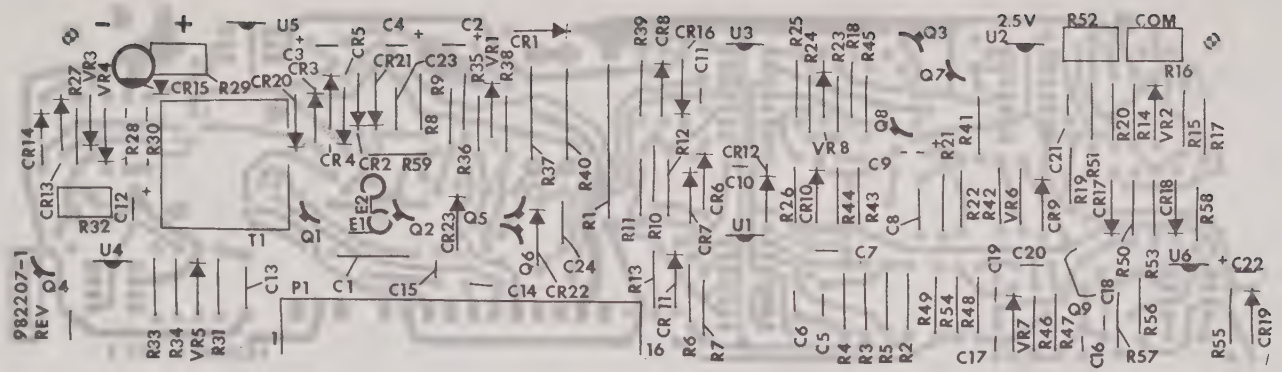
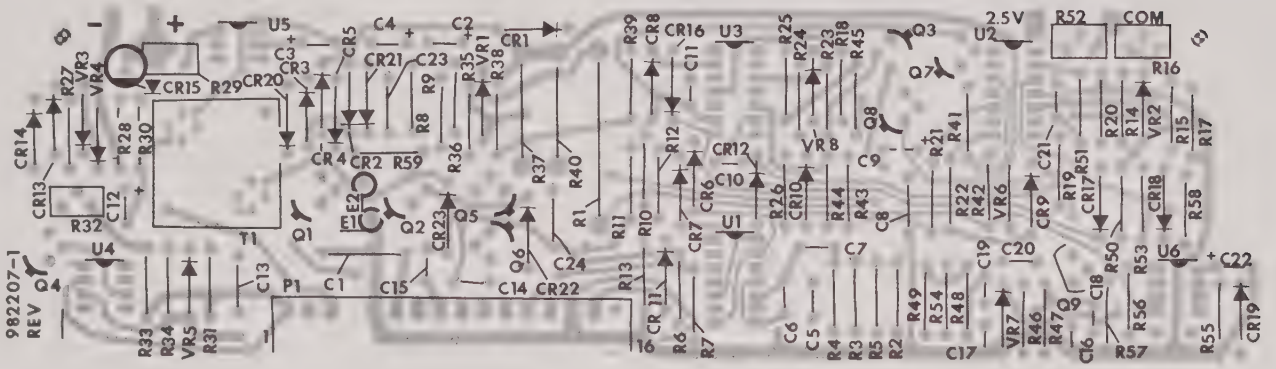


Figure 5-5 Module IIIA-Typical Component Location Photo

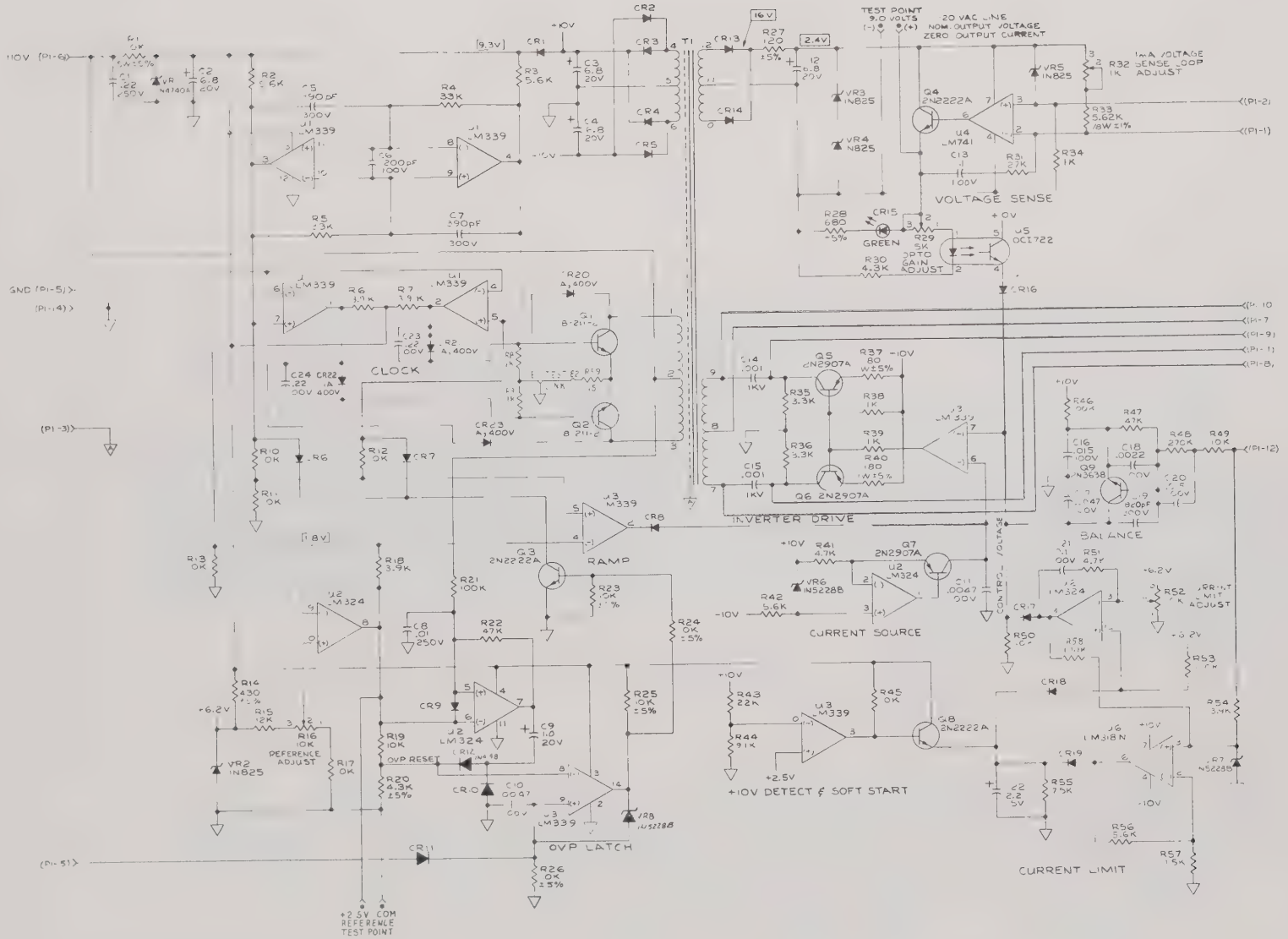


SOLDER SIDE



COMPONENT SIDE

Figure 5-6A
(A100) Printed-Circuit Board Assembly
(Modules III/IIIA)



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   a. ALL RESISTANCE IN OHMS
   b. ALL RESISTORS ARE 1/4 WATT ±2%
   c. ALL CAPACITANCE IN MICROFARADS
   d. ALL DIODES ARE 1N4148

Figure 5-6B
(A100) PRINTED CIRCUIT BOARD SCHEMATIC
(MODULES III/IIIA)

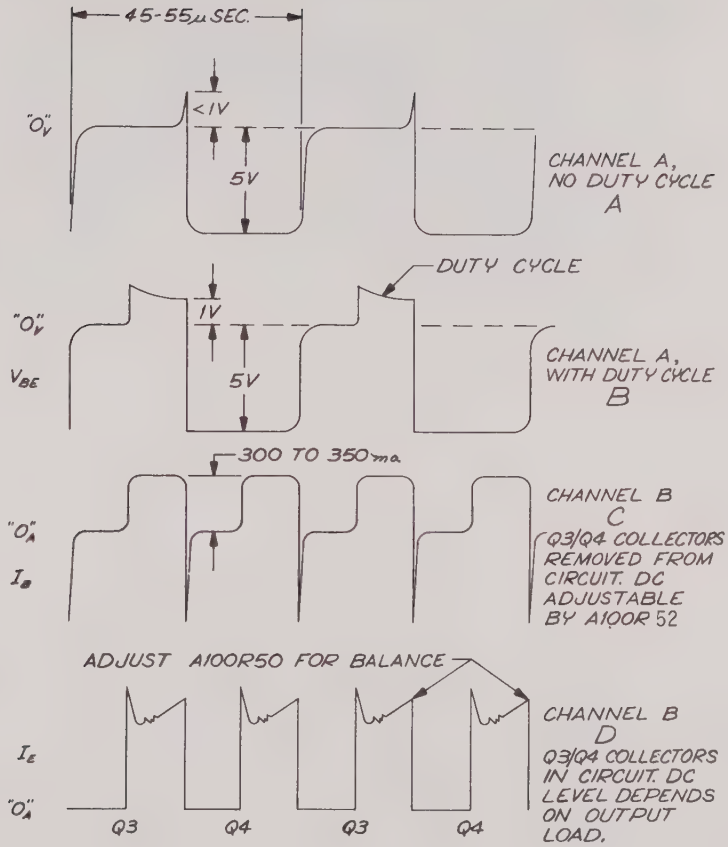
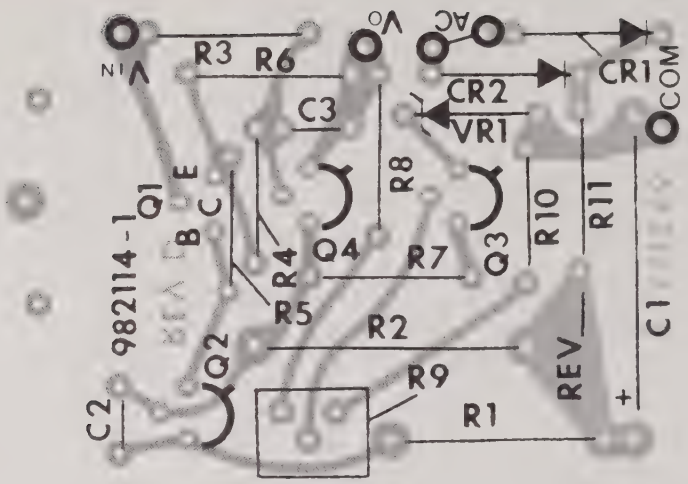


Figure 5-7 Switching Transistor Waveforms



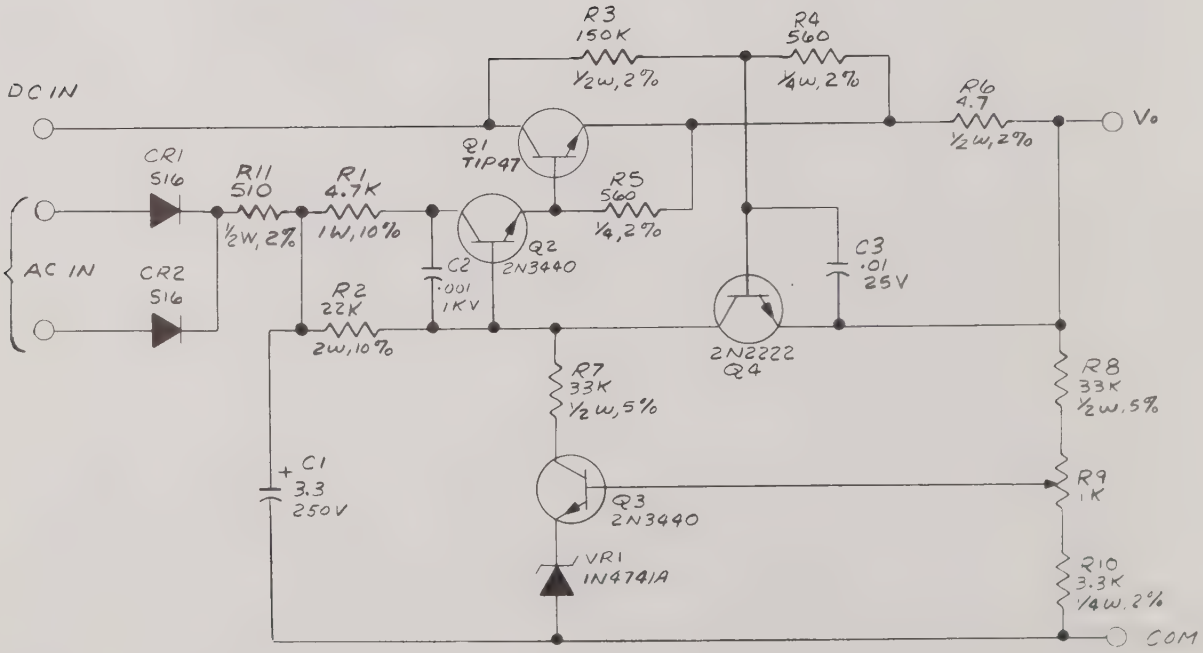
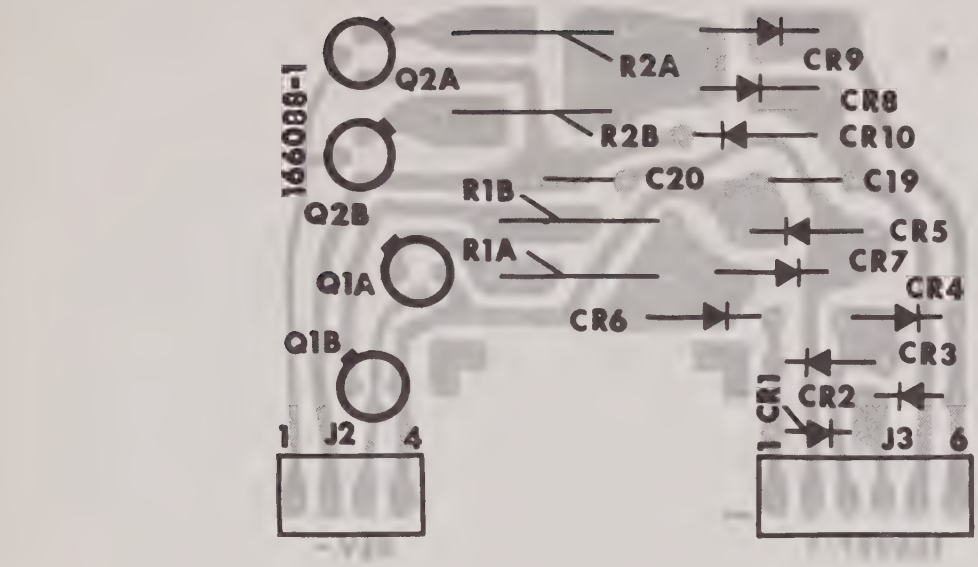


Figure 5-8
Regulator Printed-Circuit Board
Schematic and Assembly
Drawings
(Modules III/IIIA)



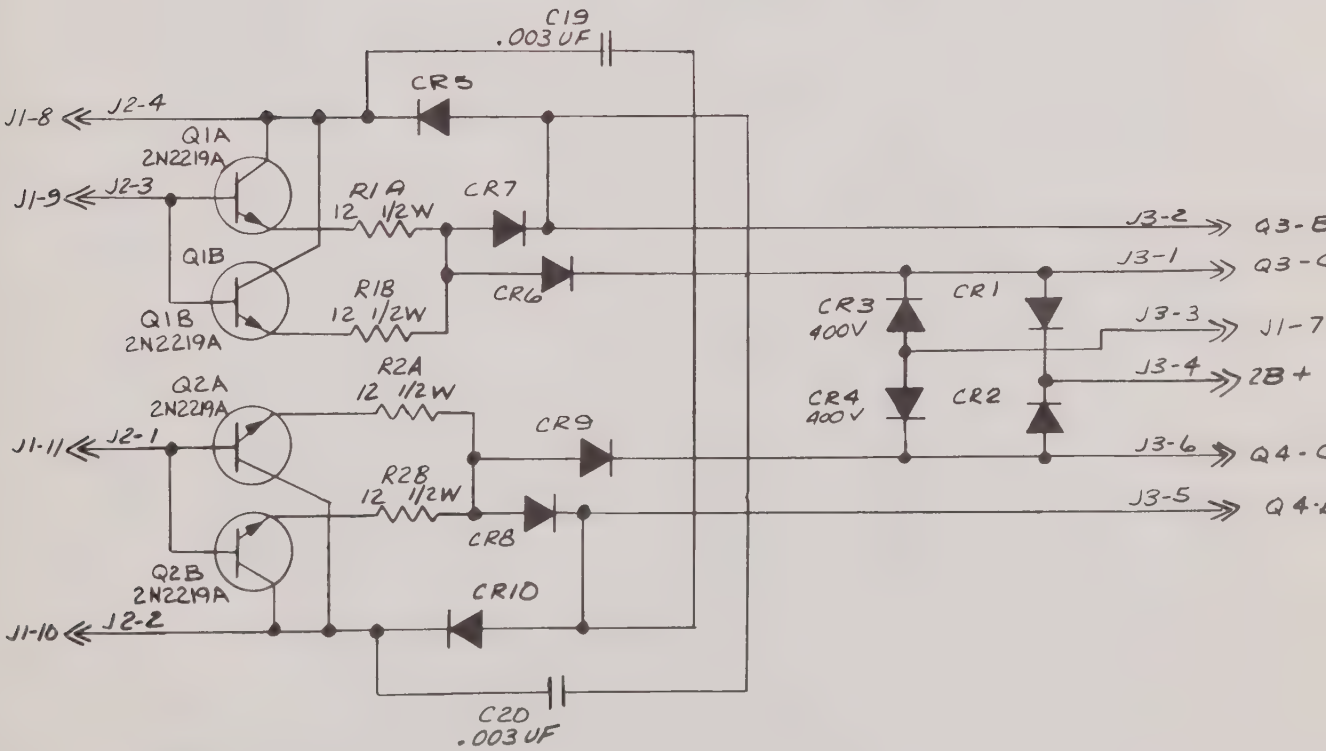


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Figure 5-9
Base Drive Printed-Circuit Board
Schematic and Assembly Drawings
(Module IIIA)

6 REPLACEABLE PARTS LISTS

6.1 INTRODUCTION

This section provides the replaceable parts lists keyed to the schematic diagram and parts location diagrams appearing in Section 5. All Module III models are covered by Table 6-1; all Module IIIA models are covered by Table 6-2.

Tables 6-3/6-4 summarize the replaceable electrical parts for the STM Control and Regulator printed-circuit boards. These boards are compatible with all models in module groups III and IIIA. Module IIIA units contain a base drive printed-circuit board, with replaceable parts as listed in Table 6-5.

Figures 5-6A, 5-8, and 5-9 (Section 5) illustrate the component layout for these boards.

6.2.1 Circuit Symbol

This is an alpha-numeric identification of the component referenced on the schematic diagram.

6.2.2 Sorensen P/N

Use this number when ordering parts. Call (603)668-4500, or direct orders to:

Sorensen Company
Replacement Parts Dept.
676 Island Pond Road
Manchester, N. H. 03103

6.2.3 Mfr., Type

This is the basic group or series under which the part is listed by a manufacturer. The coded identification or representative manufacturers is summarized below, listed alphabetically.

Mfr. Code	Manufacturer
AB	Allen Bradley Co.
AM	Ammons Instrument Co.
AX	Acushnet Capacitor Co.
BNS	Bourns, Incorporated
BUS	Bussman Mfg./Div. McGraw-Edison
CD	Cornell-Dublier Corp.
CG	Corning Glass Works
CL	Clarostat Corp.
CTS	CTS Corporation
ELA	Electra/Midland
EMC	Electromotive Manufacturing Co.
GE	General Electric Co.
GI	General Illuminating Co.
IND	Industrial Devices
IRC	International Resistance Co.
KEM	Kemet Division Union Carbide Corp.
KC	Keystone Carbon
LF	Littelfuse Corporation
MA	Motorola
MAL	P. R. Mallory Co.
NS	National Semiconductor
RAM	Ram Electronics
RCA	RCA Corporation
RCL	RCL Electronics
RDM	Radio Material Co./Div. P.R. Mallory
SAN	Sangamo Electric
SE	Seacor, Incorporated
SEM	Semtech Corporation
SP	Sprague Electric
SR	Sorensen Company
ST	Solitron Devices
STM	STM Corporation
TEL	Tel-Labs
TI	Texas Instruments
UC	Union Carbide
WH	Westinghouse Semiconductor Division
WL	Ward Leonard

Table 6-1
Replaceable Parts List
STM Module III
(Ref. Fig. 5-2, P 5-8)

CIRCUIT SYMBOL	STM Model 3.5-24	5-24	9-12	12-12	15-10	18-10	24-8.5	28-7	36-4	48-4	DESCRIPTION	SORENSEN PART NUMBER	MANUFACTURER,* TYPE
											Capacitors (uF except as noted)		
C1	x	x	x	x	x	x	x	x	x	x	1000, 200V	586052-1	STM, 91C
C2	x	x	x	x	x	x	x	x	x	x	1000, 200V	586052-1	STM, 91C
C3	x	x	x	x	x	x	x	x	x	x	0.02, 1KV	24-2029	SP, C023
C4	x	x	x	x	x	x	x	x	x	x	0.02, 1KV	24-2029	SP, C023
C5	x	x	x	x	x	x	x	x	x	x	560pF, 500V	235-7053P317	EMC, DM15
C6	x	x	x	x	x	x	x	x	x	x	1, 250V	24-2015-13	SE, MMK
C7	x	x	x	x	x	x	x	x	x	x	560pF, 500V	235-7053P317	EMC, DM15
C8	x	x	x	x							100, 25V	24-2279-14	SP, TE1211
C9	x	x									120, 10V	586057-8	UC,MIL-C-39003
			x	x							47, 20V	586385-8	UC, T110
					x	x	x				22, 35V	586058-23	UC,MIL-C-39003
							x				18, 50V	585071-44	UC,MIL-C-39003
								x	x		3.9, 75V	586386-5	UC,MIL-C-39003
C10	x	x	x	x	x	x					19500, 25V	586043-2	STM, 91S
							x	x	x	x	4600, 75V	586051-1	STM, 91S
C11	x	x	x	x	x	x	x	x	x	x	4.7, 10V	586057-2	UC,MIL-C-39003
C12	x	x	x	x	x	x	x	x	x	x	Not Used		
C13	x	x	x	x	x	x	x	x	x	x	0.01, 400V	587626-89	SE, Type 105
C14	x	x	x	x	x	x	x	x	x	x	0.01, 400V	587626-89	SE, Type 105
C15	x	x	x	x							0.1, 100V	587626-1	SE, Type 105
					x	x	x	x	x	x	0.22, 100V	587626-3	SE, Type 105
C16	x	x									120, 10V	586057-8	UC,MIL-C-39003
			x	x							47, 20V	586385-8	UC, T110
					x	x	x	x			22, 35V	586058-23	UC,MIL-C-39003
									x	x	10, 75V	586386-8	UC,MIL-C-39003
C17	x	x	x	x	x	x	x	x	x	x	0.22, 400V	587626-99	SE, Type 105
C18	x	x	x	x	x	x	x	x	x	x	1, 100V	24-2037-19	SE, MMK
C19	x	x	x	x	x	x	x	x	x	x	0.003, 600V	235-7207P51	SP
C20	x	x	x	x	x	x	x	x	x	x	0.003, 600V	235-7207P51	SP
C21	x	x	x	x	x	x	x	x	x	x	Not Used		
C22	x	x	x	x	x	x	x	x	x	x	0.003, 600V	235-7207P51	SP
											Diodes		
CR1	x	x	x	x	x	x	x	x	x	x	3S14	587566-3	SEM, 3S14
CR2	x	x	x	x	x	x	x	x	x	x	3S14	587566-3	SEM, 3S14
CR3	x	x	x	x	x	x	x	x	x	x	3S14	587566-3	SEM, 3S14
CR4	x	x	x	x	x	x	x	x	x	x	3S14	587566-3	SEM, 3S14
CR5	x	x	x	x	x	x	x	x	x	x	388A	586379-1	SEM, S1F05
CR6	x	x	x	x	x	x	x	x	x	x	388H	586379-6	SEM, S1F4
CR7	x	x	x	x	x	x	x	x	x	x	388A	586379-1	SEM, S1F05
CR8	x	x	x	x	x	x	x	x	x	x	388A	586379-1	SEM, S1F05
CR9	x	x	x	x	x	x	x	x	x	x	388H	586379-6	SEM, S1F4
CR10	x	x	x	x	x	x	x	x	x	x	388A	586379-1	SEM, S1F05
CR11	x	x	x	x	x	x	x	x			Rectifier, 200V	586462-3	SEM, SCPA2F
									x	x	Rectifier, 300V	586462-4	SEM, SCPA3F
CR12	x	x	x	x							1N4003	587565-2	SEM, S12
CR13	x	x	x	x							1N4003	587565-2	SEM, S12
CR14	x	x	x	x							1N4003	587565-2	SEM, S12
CR15	x	x	x	x							1N4003	587565-2	SEM, S12
CR16	x	x	x	x							1N4003	587565-2	SEM, S12
CR17	x	x	x	x	x	x	x	x	x	x	1N4003	587565-2	SEM, S12
CR18	x	x	x	x	x	x	x	x	x	x	Not Used		
CR19	x	x									Rectifier, 200V	586462-3	SEM, SCPA2F
CR20	x	x	x	x	x	x	x	x	x	x	388H	586379-6	SEM, S1F4
CR21	x	x	x	x	x	x	x	x	x	x	388H	586379-6	SEM, S1F4

*Ref. para. 6.2.3

Table 6-1
Replaceable Parts List
STM Module III (cont'd)

CIRCUIT SYMBOL	STM Model 3.5-24	5-24	9-12	12-12	15-10	18-10	24-8.5	28-7	36-4	48-4	DESCRIPTION	SORENSEN PART NUMBER	MANUFACTURER, TYPE
											Fuse		
F1	x	x	x	x	x	x	x	x	x	x	6A, 250V	226-7176P58	BUS, MTH-6
XF1	x	x	x	x	x	x	x	x	x	x	Fuseholder	588882-1	BUS, HTA-E
											Inductors		
L1A/B*	x	x	x	x	x	x	x	x	x	x	Coil, Toroid	586416-1	SR
L2/3/5*	x	x									Inductor Ass'y	586412-1	SR
			x	x								586412-2	SR
					x	x	x					586412-3	SR
								x				586412-4	SR
									x	x		586412-5	SR
L4	x	x									Choke Ass'y	586308-1	SR
			x	x								586308-2	SR
					x	x						586308-3	SR
							x	x				586308-4	SR
									x	x		586308-5	SR
L6 A/B	x	x									Choke Ass'y	586523-1	SR
			x	x								586524-1	SR
					x	x						586525-1	SR
							x	x				586526-1	SR
									x	x		586527-1	SR
L7	x	x	x	x	x	x	x	x	x	x	Choke Ass'y	586471-1	SR
											Transistors		
Q1	x	x	x	x	x	x	x	x	x	x	2N2219A	386-7249P32	GE, 2N2219A
Q2	x	x	x	x	x	x	x	x	x	x	2N2219A	386-7249P32	GE, 2N2219A
Q3	x	x	x	x							2N3902	588948-1	MA
					x	x	x	x	x	x	2N3902	588948-2	MA
Q4	x	x	x	x							2N3902	588948-1	MA
					x	x	x	x	x	x	2N3902	588948-2	MA
Q5	x	x	x	x							2N2907A	386-7249P58	GE, 2N2907A
Q6	x	x	x	x							2N6027	386-7304P1	GE, 2N6027
					x	x	x	x	x	x	2N4990	586063-2	GE, 2N4990
											Resistors (ohms, ±10% except as noted)		
R1	x	x	x	x	x	x	x	x	x	x	6.8, 1W	28-713	AB, GB68G1
R2	x	x	x	x	x	x	x	x	x	x	6.8, 1W	28-713	AB, GB68G1
R3	x	x	x	x	x	x	x	x	x	x	180, 1/2W	280-1145P47	AB, EB
R4	x	x	x	x	x	x	x	x	x	x	180, 1/2W	280-1145P47	AB, EB
R5	x	x	x	x							0.33, 5W, 5%	586054-7	RCL, T-5

*L1 supplied in stack of assembly 586412-1, 2, 3, 4 and 5.
**L2, L3, and L5 part of assembly 586412-1, 2, 3, 4, and 5.

Table 6-1
Replaceable Parts List
STM Module III (con't)

CIRCUIT SYMBOL	STM Model 3.5-24	5-24	9-12	12-12	15-10	18-10	24-8.5	28-7	36-4	48-4	DESCRIPTION	SORENSEN PART NUMBER	MANUFACTURER, TYPE
											Resistors (ohms, ±10% except as noted) - (cont'd)		
R5 (con't)				x	x	x	x	x	x		0.27, 7W, 5%	27-470-11	WL, Type 7XM
R6	x	x	x	x	x	x	x	x	x	x	Not Used		
R7	x	x	x	x	x	x	x	x	x	x	330, 2W	280-1147P56	AB, HB
R8	x	x	x	x	x	x	x	x	x	x	330, 2W	280-1147P56	AB, HB
R9	x	x	x	x							10, 1/2W	280-1145P2	AB, EB
					x	x	x	x	x	x	Not Used		
R10	x	x									0.18, 3W	27-397-7	WL, Type 3X
			x	x	x						0.56, 3W	27-397-19	WL, Type 3X
						x	x	x			1.2, 3W, 5%	27-397-27	WL, Type 3X
									x	x	6.8, 3W, 5%	27-397-45	WL, Type 3X
R11	x	x	x	x							100, 1/2W	280-1145P38	AB, EB
R12	x	x									2700, 1/2W	28-2109	RC, 206F
			x	x							5600, 1/2W	28-2003	RC, 206F
R13	x	x	x	x	x	x	x	x	x	x	Not Used		
R14	x	x	x	x	x	x	x	x			Variable, 2K	586371-5	BNS, 3006P
									x	x	Variable, 5K	586371-6	BNS, 3006P
R15	x										5.36K, 1/4W, 1%	586250-109	ELA, MF4
		x	x	x							1300, 1/4W, 1%	28-1333	IRC, CEA-TO
					x	x					681, 1/4W, 1%	586250-66	ELA, MF4
							x	x			422, 1/4W, 1%	586250-56	ELA, MF4
									x	x	681, 1/4W, 1%	586250-66	ELA, MF4
R16	x	x	x	x							3.3K, 1/2W, 5%	280-1145P91	AB, EB
R17	x	x									1300, 1/4W, 1%	28-1333	IRC, CEA-TO
			x	x							7150, 1/4W, 1%	586250-115	ELA, MF4
					x	x					280, 1/4W, 1%	28-1284	IRC, CEA-TO
							x	x			422, 1/4W, 1%	586250-56	ELA, MF4
									x	x	1300, 1/4W, 1%	28-1333	IRC, CEA-TO
R18	x										5.36K, 1/4W, 1%	586250-109	ELA, MF4
		x	x	x							3320, 1/4W, 1%	586250-99	ELA, MF4
R19	x	x	x	x	x	x	x	x	x	x	33, 1/2W	280-1145P20	AB, EB
R20	x	x	x	x	x	x	x	x	x	x	Not Used		
R21	x										2.8, 25W, 3%	586369-506	RCL, AL-25
		x									4.02, 25W, 3%	586369-511	RCL, AL-25
			x								8.66, 25W, 1%	586369-187	RCL, AL-25
				x							15, 25W, 3%	586369-518	RCL, AL-25
					x						24.9, 25W, 3%	586369-522	RCL, AL-25
						x					34.8, 25W, 3%	586369-526	RCL, AL-25
							x				45.3, 25W, 3%	586369-529	RCL, AL-25
								x			75, 25W, 3%	586369-532	RCL, AL-25
									x		137, 25W, 1%	586369-302	RCL, AL-25
										x	221, 25W, 3%	586369-538	RCL, AL-25
R22	x	x	x	x	x	x	x	x	x	x	Not Used		
R23		x									1500, 1/8W, 1%	586055-185	ELA, MF4
				x							3480, 1/8W, 1%	586055-100	ELA, MF4
					x						2940, 1/8W, 1%	586055-186	ELA, MF4
							x				4990, 1/8W, 1%	586055-187	ELA, MF4
										x	13K, 1/8W, 1%	586055-189	ELA, MF4
R24	x										1.0K, 1/2W	280-1145P74	AB, EB
		x	x	x	x	x	x	x	x	x	1.2K, 1/2W	280-1145P77	AB, EB
R25	x	x									2940, 1/8W, 1%	586055-186	ELA, MF4
			x	x							5900, 1/8W, 1%	586055-111	ELA, MF4
					x	x					12.7K, 1/8W, 1%	586055-127	ELA, MF4
							x	x			18.7K, 1/8W, 1%	586055-135	ELA, MF4
									x	x	28.7K, 1/8W, 1%	586055-144	ELA, MF4
R26	x	x									Variable, 2K	586371-5	BNS, 3006P
			x	x	x	x					Variable, 5K	586371-6	BNS, 3006P
							x	x			Variable, 10K	586371-7	BNS, 3006P
									x	x	Variable, 20K	586371-8	BNS, 3006P

Table 6-1
Replaceable Parts List
STM Module III (con't)

CIRCUIT SYMBOL	STM Model 3.5-24	5-24	9-12	12-12	15-10	18-10	24-8.5	28-7	36-4	48-4	DESCRIPTION	SORENSEN PART NUMBER	MANUFACTURER, TYPE
											Resistors (ohms, ±10%) -(cont'd)		
R27	x	x	x	x	x	x	x	x	x	x	Not Used		
R28	x	x	x	x	x	x	x	x	x	x	47K, 2W	280-1147P134	AB, HB
R29	x	x	x	x	x	x	x	x	x	x	47K, 2W	280-1147P134	AB, HB
RT1	x	x	x	x	x	x	x	x	x	x	Thermistor	165541-1	KC,RL10007-1.31
											Transformers		
T1	x	x									Power	586280-1	SR
			x	x								586275-1	SR
					x	x						586292-1	SR
							x					586292-4	SR
								x				586292-2	SR
									x	x		586292-3	SR
T2	x	x	x	x	x	x	x	x	x	x	Pulse	586340-1	SR
VR1	x	x	x	x							Diode, Zener 1N825	588105-3	MA, 1N825
											Miscellaneous		
											Schematic Diagrams: MODEL		
	x										3.5-24	D586446	SR
		x									5-24	D586441	SR
			x								9-12	D586447	SR
				x							12-12	D586442	SR
					x						15-10	D586448	SR
						x					18-10	D586443	SR
							x				24-8.5	D586449	SR
								x			28-7	D586444	SR
									x		36-4	D586450	SR
										x	48-4	D586445	SR
TB1	x	x	x	x	x	x	x	x	x	x	Terminal Block (Input)	586555-1	Kulka, 1699-7
TB2	x	x	x	x	x	x	x	x	x	x	Terminal Block (Output)	247-7204P102	Kulka, 602 (Type Y)
	x	x	x	x	x	x	x	x	x	x	A100 Control PCB Assembly	982207-1	SR
	x	x	x	x	x	x	x	x	x	x	Regulator PCB Assembly	982114-1	SR

Table 6-2
Replaceable Parts List
STM Module IIIA
(Ref. Fig. 5-3, P 5-9)

CIRCUIT SYMBOL	STM Model 3.5-36	5-36	9-20	12-20	15-15	18-15	24-13	28-11	36-6	48-6	DESCRIPTION	SORENSEN PART NUMBER	MANUFACTURER,* TYPE
											Capacitors (uF except as noted)		
C1	x	x	x	x	x	x	x	x	x	x	1000, 200V	586052-1	STM, 91C
C2	x	x	x	x	x	x	x	x	x	x	1000, 200V	586052-1	STM, 91C
C3	x	x	x	x	x	x	x	x	x	x	0.02, 1KV	24-2029	SP, C023
C4	x	x	x	x	x	x	x	x	x	x	0.02, 1KV	24-2029	SP, C023
C5	x	x	x	x	x	x	x	x	x	x	0.001, 1KV	235-7421P14	RDM, JF
C6	x	x	x	x	x	x	x	x	x	x	680pF, 1KV	235-7421P10	RDM, JF
C7	x	x	x	x	x	x	x	x	x	x	0.001, 1KV	235-7421P14	RDM, JF
C8	x	x	x	x							100, 25V	24-2279-14	SP, TE1211
C9	x	x									220, 10V	586057-10	UC,MIL-C-39003
			x	x							100, 20V	586385-10	UC, T110
					x	x	x				47, 35V	586058-27	UC,MIL-C-39003
							x				18, 50V	585071-44	SP, 150D
								x	x		10, 75V	586386-8	UC,MIL-C-39003
C10A/B	x	x	x	x	x	x					19500, 25V	586043-2	STM, 91S
							x	x	x	x	4600, 75V	586051-1	STM, 91S
C11	x	x	x	x	x	x	x	x	x	x	4.7, 10V	586057-2	UC,MIL-C-39003
C12	x	x	x	x	x	x	x	x	x	x	Not Used		
C13,14	x	x	x	x	x	x	x	x	x	x	0.01, 400V	587626-89	SE, Type 105
C15A	x	x	x	x	x	x					0.1, 100V	587626-1	SE, Type 105
							x	x	x	x	0.22, 100V	587626-3	SE, Type 105
C15B	x	x	x	x	x	x	x	x	x	x	0.22, 100V	587626-3	SE, Type 105
C16	x	x									120, 10V	586057-8	UC,MIL-C-39003
			x	x							47, 20V	586385-8	UC, T110
					x	x	x				22, 35V	586058-23	UC,MIL-C-39003
							x				18, 50V	585071-44	SP, 150D
								x	x		10, 75V	586386-8	UC,MIL-C-39003
C17	x	x	x	x							0.22, 400V	587626-99	SE, Type 105
C18	x	x	x	x	x	x	x	x	x	x	1, 100V	24-2037-19	SE, MMK
C19	x	x	x	x	x	x	x	x	x	x	Not Used (See Table 6-5)		
C20	x	x	x	x	x	x	x	x	x	x	Not Used (See Table 6-5)		
C21				x	x	x	x	x	x	x	0.47, 35V	586058-3	UC,MIL-C-39003
C22	x	x	x	x	x	x	x	x	x	x	0.003, 600V	235-7207P51	SP
C23	x	x	x	x	x	x	x	x	x	x	0.22, 250V	24-2015-17	SE, MMK
C24	x	x	x	x	x	x	x	x	x	x	270pF, 500V	235-7053P297	EMC, DM15
C25	x	x									0.001, 1KV	235-7421P14	RDM, JF
C26,27	x	x	x	x	x	x	x	x	x	x	0.001, 1.5KV	235-7355P316	WL, 3X
											Diodes		
CR1	x	x	x	x	x	x	x	x	x	x	Bridge	980893-3	VARO, VK647
CR2	x	x	x	x	x	x	x	x	x	x	Not Used		
CR3	x	x	x	x	x	x	x	x	x	x	Not Used		
CR4	x	x	x	x	x	x	x	x	x	x	Not Used		
CR5	x	x	x	x	x	x	x	x	x	x	Not Used (See Table 6-5)		
CR6	x	x	x	x	x	x	x	x	x	x	Not Used		
CR7	x	x	x	x	x	x	x	x	x	x	Not Used		
CR8	x	x	x	x	x	x	x	x	x	x	Not Used		
CR9	x	x	x	x	x	x	x	x	x	x	Not Used		
CR10	x	x	x	x	x	x	x	x	x	x	Not Used		
CR11			x	x	x	x	x	x			Rectifier, 200V	586462-3	SEM, SCPA2F
									x	x	Rectifier, 300V	586462-4	SEM, SCPA3F
CR12	x	x	x	x							1N4003	587565-2	SEM, S12
CR13	x	x	x	x							1N4003	587565-2	SEM, S12
CR14	x	x	x	x							1N4003	587565-2	SEM, S12
CR15	x	x	x	x							1N4003	587565-2	SEM, S12
CR16	x	x	x	x							1N4003	587565-2	SEM, S12
CR17	x	x	x	x	x	x	x	x	x	x	1N4003	587565-2	SEM, S12

*Ref. para. 6.2.3

Table 6-2
Replaceable Parts List
STM Module IIIA (cont'd)

CIRCUIT SYMBOL	STM Model 3.5-36	5-36	9-20	12-20	15-15	18-15	24-13	28-11	36-6	48-6	DESCRIPTION	SORENSEN PART NUMBER	MANUFACTURER, TYPE
											Diodes - (cont'd)		
CR18	x	x	x	x	x	x	x	x	x	x	Not Used		
CR19			x	x	x	x	x				Rectifier, 200V	586462-3	SEM, SCPA2F
CR20	x	x	x	x	x	x	x	x	x	x	Not Used		
CR21	x	x									Rectifier	165196-2	TRW, SD5178
CR22	x	x									Rectifier	165196-2	TRW, SD5178
											Fuse		
F1	x	x	x	x	x	x	x	x	x	x	8A, 125V	226-7176P54	BUS, 125VGLH
XF1	x	x	x	x	x	x	x	x	x	x	Fuseholder	588882-1	BUS, HTA-E
											Inductors		
L1A/B	x	x	x	x	x	x	x	x	x	x	Coil, Toroid, 650uH	586676-1	SR
L2*	x	x									Choke Assy, 120uH	586548-1	SR
			x	x								586548-2	SR
					x	x	x					586548-3	SR
								x				586548-4	SR
									x	x		586548-5	SR
L3*	x	x									Choke Assy, 120uH	586548-1	SR
			x	x								586548-2	SR
					x	x	x					586548-3	SR
								x				586548-4	SR
									x	x		586548-5	SR
L4	x	x									Choke Assy, 63uH	586538-1	SR
			x	x								586538-2	SR
					x	x						586538-3	SR
							x					586538-4	SR
								x				586538-5	SR
									x	x		586538-6	SR
L5*	x	x									Choke Assy, 120uH	586548-1	SR
			x	x								586548-2	SR
					x	x	x					586548-3	SR
								x				586548-4	SR
									x	x		586548-5	SR
L6A/B	x	x									Choke Assy, 30uH	586523-1	SR
			x	x								586524-1	SR
					x	x						586525-1	SR
							x	x				586526-1	SR
									x	x		586527-1	SR
L7	x	x	x	x	x	x	x	x	x	x	Choke Assy, 170uH	586471-1	SR
L8	x	x	x	x	x	x	x	x	x	x	Choke Assy	165604-1	SR
											Transistors		
Q1	x	x	x	x	x	x	x	x	x	x	Not Used (See Table 6-5)		
Q2	x	x	x	x	x	x	x	x	x	x	Not Used (See Table 6-5)		
Q3,Q4	x	x	x	x							2N6308	589698-3	MA
					x	x	x	x	x	x	65115	588150-1	RCA
Q5	x	x	x	x							2N2907A	386-7249P58	GE
Q6	x	x	x	x							2N6027	386-7304P1	GE
					x	x	x	x	x	x	2N4987	586063-1	GE

*L2, 3, 5 P/O Assembly 586548

Table 6-2
Replaceable Parts List
STM Module IIIA (cont'd)

CIRCUIT SYMBOL	STM Model 3.5-36	5-36	9-20	12-20	15-15	18-15	24-13	28-11	36-6	48-6	DESCRIPTION	SORENSEN PART NUMBER	MANUFACTURER, TYPE
											Resistors (ohms, ±10% except as noted)		
R1	x	x	x	x	x	x	x	x	x	x	1K, 2W	280-1147P74	AB, HB
R2	x	x	x	x	x	x	x	x	x	x	20K, 6W, 5%	167397-1	Sage 1550S
R3	x	x	x	x							68, 1/2W	280-1145P32	AB, EB
					x	x	x	x	x	x	180, 1/2W	280-1145P47	AB, EB
R4	x	x	x	x							68, 1/2W	280-1145P32	AB, EB
					x	x	x	x	x	x	180, 1/2W	280-1145P47	AB, EB
R5	x										0.27, 6.5W, 5%	586054-6	RCL, T-5
		x	x	x							0.22, 6.5W, 5%	586054-5	RCL, T-5
					x	x	x	x	x	x	0.18, 5W	27-470-7	WL, Type 7XM
R6	x	x	x	x	x	x	x	x	x	x	220, 6.5W, 5%	586054-41	RCL, T-5
R7	x	x	x	x	x	x	x	x	x	x	220, 6.5W, 5%	586054-41	RCL, T-5
R8	x	x	x	x	x	x	x	x	x	x	220, 6.5W. 5%	586054-41	RCL, T-5
R9	x	x	x	x							10, 1/2W	280-1145P2	AB, EB
R10	x	x									0.10, 3W	27-397-1	WL, Type 3X
			x	x							0.22, 3W	27-397-9	WL, Type 3X
					x	x	x	x			0.56, 3W	27-397-19	WL, Type 3X
									x	x	3.3, 3W, 5%	27-397-37	WL, Type 3X
R11	x	x	x	x							82, 1/2W	28-2000	AB, RC200F
R12	x	x									2700, 1/2W	28-2109	RC, 206F
			x	x							5600, 1/2W	28-2003	RC, 206F
R13	x	x	x	x	x	x	x	x	x	x	Not Used		
R14	x	x	x	x	x	x	x	x			Variable, 2K	586371-5	BNS, 3006P
									x	x	Variable, 5K	586371-6	BNS, 3006P
R15	x	x	x	x							1300, 1/4W, 1%	28-1333	IRC, CEA-TO
					x	x					681, 1/4W, 1%	586250-66	ELA, MF4
							x	x			422, 1/4W, 1%	586250-56	ELA, MF4
									x	x	681, 1/4W, 1%	586250-66	ELA, MF4
R16	x	x	x	x							3300, 1/2W	280-1145P91	AB, EB
R17	x	x									1300, 1/4W, 1%	28-1333	IRC, CEA-TO
			x	x							7150, 1/4W, 1%	586250-115	ELA, MF4
					x	x					280, 1/4W, 1%	28-1284	IRC, CEA-TO
							x	x			422, 1/4W, 1%	586250-56	ELA, MF4
									x	x	1300, 1/4W, 1%	28-1333	IRC, CEA-TO
R18	x	x	x	x							3.3K, 1/4W, 1%	28-1326	IRC, CEA-TO
R19	x	x	x	x	x	x	x	x	x	x	33, 1/2W	280-1145P20	AB, EB
R20	x	x	x	x	x	x	x	x	x	x	Not Used		
R21	x										1.82, 50W, 3%	586677-502	RCL, AL-50
		x									2.80, 50W, 3%	586677-506	RCL, AL-50
			x								6.04, 50W, 3%	586677-514	RCL, AL-50
				x							10, 50W, 3%	586677-516	RCL, AL-50
					x						18.2, 50W, 3%	586677-519	RCL, AL-50
						x					20, 50W, 3%	586677-520	RCL, AL-50
							x				34.8, 50W, 3%	586677-526	RCL, AL-50
								x			45.3, 50W, 3%	586677-529	RCL, AL-50
									x		86.6, 50W, 3%	586677-568	RCL, AL-50
										x	121, 50W, 3%	586677-534	RCL, AL-50
R22	x	x	x	x	x	x	x	x	x	x	Not Used		
R23		x									1500, 1/8W, 1%	586055-185	ELA, MF4
				x							3480, 1/8W, 1%	586055-100	ELA, MF4
					x						2940, 1/8W, 1%	586055-186	ELA, MF4
							x				4990, 1/8W, 1%	586055-187	ELA, MF4
										x	13K, 1/8W, 1%	586055-189	ELA, MF4
R24	x	x	x	x	x	x	x	x	x	x	1K, 1/2W	280-1145P74	AB, EB
R25	x	x									2940, 1/8W, 1%	586055-186	ELA, MF4
			x	x							5900, 1/8W, 1%	586055-111	ELA, MF4
					x	x					12.7K, 1/8W, 1%	586055-127	ELA, MF4
							x	x			18.7K, 1/8W, 1%	586055-135	ELA, MF4
									x	x	28.7K, 1/8W, 1%	586055-144	ELA, MF4

Table 6-2
Replaceable Parts List
STM Module IIIA (cont'd)

CIRCUIT SYMBOL	STM Model 3.5-36	5-36	9-20	12-20	15-15	18-15	24-13	28-11	36-6	48-6	DESCRIPTION	SORENSEN PART NUMBER	MANUFACTURER, TYPE
											Resistors (ohms, ±10%)-(cont'd)		
R26	x	x									Variable, 2K	586371-5	BNS, 3006P
			x	x	x	x					Variable, 5K	586371-6	BNS, 3006P
							x	x			Variable, 10K	586371-7	BNS, 3006P
									x	x	Variable, 20K	586371-8	BNS, 3006P
R27	x	x	x	x	x	x	x	x	x	x	Not Used		
R28	x	x	x	x	x	x	x	x	x	x	47K, 2W	280-1147P134	AB, HB
R29	x	x									10, 1/2W	280-1145P2	AB, EB
R30,31	x	x	x	x	x	x	x	x	x	x	330, 3W	27-397-85	EMC, DM20
RT1	x	x	x	x	x	x	x	x	x	x	Thermistor	165541-1	KC, RL10007-1.31
											Transformers		
T1	x	x									Power	586513-1	SR
			x	x								586513-2	SR
					x	x						586515-1	SR
							x					586515-2	SR
								x				586515-3	SR
									x	x		586516-1	SR
T2	x	x	x	x	x	x	x	x	x	x	Pulse	586340-1	SR
VR1	x	x	x	x							Diode, Zener 1N825	588105-3	MA
											Miscellaneous		
											Schematic Diagrams: MODEL		
	x										3.5-36	D586650	SR
		x									5-36	D586651	SR
			x								9-20	D586652	SR
				x							12-20	D586653	SR
					x						15-15	D586654	SR
						x					18-15	D586655	SR
							x				24-13	D586656	SR
								x			28-11	D586657	SR
									x		36-6	D586658	SR
										x	48-6	D586659	SR
TB1	x	x	x	x	x	x	x	x	x	x	Terminal Block (Input)	586555-1	Kulka, 1699-7
TB2	x	x	x	x	x	x	x	x	x	x	Terminal Block (Output)	247-7204P102	Kulka, 602, (Type Y)
	x	x	x	x	x	x	x	x	x	x	A100 Control PCB Assembly	982207-1	SR
	x	x	x	x	x	x	x	x	x	x	Regulator PCB Assembly	982114-1	SR
	x	x	x	x	x	x	x	x	x	x	Base Drive PCB Assembly	166088-1	SR

Table 6-3
Replaceable Parts List
Control PCB Ass'y (A-100) 982207-1
All STM Models

CIRCUIT SYMBOL	DESCRIPTION	SORENSEN PART NUMBER	MANUFACTURER, TYPE
	Capacitors (uF except as noted)		
C1	0.22, 250V	24-2015-17	SE, MMK
C2	6.8, 20V	235-7395P51	SP, 196D
C3	6.8, 20V	235-7395P51	SP, 196D
C4	6.8, 20V	235-7395P51	SP, 196D
C5	390pF, 300V	235-7053P147	EMC, DM15
C6	1200pF, 300V	235-7355P44	EMC, DM20
C7	390pF, 300V	235-7053P147	EMC, DM15
C8	.01, 250V	24-2015-1	SE, MMK
C9	1.0, 35V	235-7395P76	SP, 196D
C10	.0047, 100V	235-7193P3	Capar
C11	.0047, 100V	235-7193P3	Capar
C12	6.8, 20V	235-7395P51	SP, 196D
C13	0.1, 100V	24-2037-7	SE, MMK
C14	.001, 1kV	235-7421P14	RDM, JF
C15	.001, 1kV	235-7421P14	RDM, JF
C16	.015, 100V	235-7193P10	Capar
C17	.0047, 100V	235-7193P3	Capar
C18	.0022, 100V	235-7193P2	Capar
C19	820pF, 300V	235-7053P334	EMC, DM15
C20	.015, 100V	235-7193P10	Capar
C21	0.1, 100V	235-7193P7	Capar
C22	2.2, 15V	235-7395P34	SP, 196D
C23	.22, 100V	24-2037-11	SE, MMK
C24	.22, 100V	24-2037-11	SE, MMK
	Diodes		
CR1	1N4148	322-7220P1	ITT
CR2	1N4148	322-7200P1	ITT
CR3	1N4148	322-7220P1	ITT
CR4	1N4148	322-7220P1	ITT
CR5	1N4148	322-7220P1	ITT
CR6	1N4148	322-7220P1	ITT
CR7	1N4148	322-7220P1	ITT
CR8	1N4148	322-7220P1	ITT
CR9	1N4148	322-7220P1	ITT
CR10	1N4148	322-7220P1	ITT
CR11	1N4148	322-7220P1	ITT
CR12	1N4148	322-7220P1	ITT
CR13	1N4148	322-7220P1	ITT
CR14	1N4148	322-7220P1	ITT
CR15	LED, Green	167793-1	HP, 5082-4955
CR16	1N4148	322-7220P1	ITT
CR17	1N4148	322-7220P1	ITT
CR18	1N4148	322-7220P1	ITT
CR19	1N4148	322-7220P1	ITT
CR20	SS2998	587306-6	Semtech
CR21	SS2998	587306-6	Semtech
CR22	SS2998	587306-6	Semtech
CR23	SS2998	587306-6	Semtech
	Transistors		
Q1	2N3439, Selected	18-211-2	RCA
Q2	2N3439, Selected	18-211-2	RCA
Q3	2N2222A	386-7249P57	RCA
Q4	2N2222A	386-7249P57	RCA
Q5	2N2907A	386-7249P58	GE
Q6	2N2907A	386-7249P58	GE

Table 6-3
Replaceable Parts List (Cont'd)
Control PCB Ass'y (A-100) 982207-1
All STM Models

CIRCUIT SYMBOL	DESCRIPTION	SORENSEN PART NUMBER	MANUFACTURER, TYPE
	Transistors (cont'd)		
Q7	2N2907A	386-7249P58	GE
Q8	2N2222A	386-7249P57	RCA
Q9	2N3638	18-143	Fairchild
	Resistors (ohms, 1/4W, ±2% unless noted)		
R1	10K, 5W, 5%	586054-61	Tel-Labs, EL5
R2	5.6K	585108-47	CG, C4
R3	5.6K	585108-47	CG, C4
R4	33K	585108-125	CG, C4
R5	33K	585108-125	CG, C4
R6	3.9K	585108-39	CG, C4
R7	3.9K	585108-39	CG, C4
R8	1.0K	585108-11	CG, C4
R9	1.0K	585108-11	CG, C4
R10	10K	585108-59	CG, C4
R11	10K	585108-59	CG, C4
R12	10K	585108-59	CG, C4
R13	10K	585108-59	CG, C4
R14	430	280-1171P60	MIL-R-11A
R15	12K	585108-105	CG, C4
R16	10K, 1/2W, Variable	585370-7	BNS, 3389H
R17	10K	585108-59	CG, C4
R18	3.9K	585108-39	CG, C4
R19	10K	585108-59	CG, C4
R20	4.3K	280-1171P96	MIL-R-11A
R21	100K	585108-149	CG, C4
R22	47K	585108-133	CG, C4
R23	10K	280-1171P109	MIL-R-11A
R24	10K	280-1171P109	MIL-R-11A
R25	10K	280-1171P109	MIL-R-11A
R26	10K	280-1171P109	MIL-R-11A
R27	120	280-1171P40	MIL-R-11A
R28	680	280-1171P67	MIL-R-11A
R29	5.0K, 1/2W, Variable	586370-6	BNS, 3389H
R30	4.3K	585108-41	CG, C4
R31	27K	585108-121	CG, C4
R32	1.0K, 1/2W, Variable	586370-4	BNS, 3389H
R33	5.62K, 1/8W, 1%	586250-110	Electra Mfg., MF4
R34	1.0K	585108-11	CG, C4
R35	3.3K	585108-35	CG, C4
R36	3.3K	585108-35	CG, C4
R37	180, 1W, 5%	280-1146P46	AB, RC 30/32
R38	1.0K	585108-11	CG, C4
R39	1.0K	585108-11	CG, C4
R40	180, 1W, 5%	280-1146P46	AB, RC 30/32
R41	4.7K	585108-43	CG, C4
R42	5.6K	585108-47	CG, C4
R43	22K	585108-117	CG, C4
R44	9.1K	585108-57	CG, C4
R45	10K	585108-59	CG, C4
R46	100K	585108-149	CG, C4
R47	47K	585108-133	CG, C4
R48	270K	585108-177	CG, C4
R49	10K	585108-59	CG, C4
R50	10K	585108-59	CG, C4
R51	4.7K	585108-43	CG, C4
R52	10K, 1/2W, Variable	586370-7	BNS, 3389H
R53	100K	585108-149	CG, C4

Table 6-3
Replaceable Parts List (cont'd)
Control PCB Ass'y (A-100) 982207-1
All STM Models

CIRCUIT SYMBOL	DESCRIPTION	SORENSEN PART NUMBER	MANUFACTURER, TYPE
	Resistors (ohms, 1/4W, ±2% unless noted - cont'd)		
R54	3.9K	585108-39	CG, C4
R55	7.5K	585108-53	CG, C4
R56	5.6K	585108-47	CG, C4
R57	1.5K	585108-19	CG, C4
R58	220K	585108-179	CG, C4
R59	15, 5%	280-1171P7	MIL-R-11A
T1	Bias Transformer Ass'y	589958-2	SR
	Integrated Circuits		
U1	LM339N	166970-1	NS
U2	LM324N	980100-1	NS
U3	LM339N	166970-1	NS
U4	LM741CH	586372-3	NS
U5	Opto-Isolator	586463-3	TI, OCI722-1
U6	LM318N	166971-1	NS
	Zener Diodes		
VR1	1N4740A	588102-7	MA
VR2	1N825	588105-3	MA
VR3	1N825	588105-3	MA
VR4	1N825	588105-3	MA
VR5	1N825	588105-3	MA
VR6	1N5228B	588101-5	MA
VR7	1N5228B	588101-5	MA
VR8	1N5228B	588101-5	MA
	Miscellaneous		
	Schematic	983098	SR
	PCB (No Components)	982208-1	SR

Table 6-4
Replaceable Parts List
Regulator PCB Ass'y 982114
All STM Models
(Ref. Fig. 5-8, P. 5-14)

CIRCUIT SYMBOL	DESCRIPTION	SORENSEN PART NUMBER	MANUFACTURER, TYPE
	Capacitors (uF except as noted)		
C1	3.3, 250V	235-7437P7	SP, 600D
C2	0.001, 1KV	235-7421P14	RMD, JF
C3	0.01, 25V	235-7426P1	RMD, M25
	Rectifiers (Diodes)		
CR1	Rectifier, S16	587565-4	SEM, S16
CR2	Rectifier, S16	587565-4	SEM, S16
	Transistors		
Q1	TIP47	589802-1	TI
Q2	2N3440	386-7249P13	RCA
Q3	2N3440	386-7249P13	RCA
Q4	2N2222A	386-7249P57	RCA
	Resistors (ohms, ±10% except as noted)		
R1	4.7K, 1W	280-1180P98	AB, 032
R2	22K, 2W	280-1147P122	AB, EB
R3	150K, 1/2W	585326-219	CG, C5
R4	1.5K, 1/4W, 2%	585108-19	CG, C4
R5	560, 1/4W, 2%	585108-91	CG, C4
R6	4.7, 1/2W, 2%	585326-3	CG, C5
R7	33K, 1/2W	585326-188	CG, C5
R8	33K, 1/2W	585326-188	CG, C5
R9	1K, Variable	586370-4	BNS, 3389H
R10	3.3K, 1/4W, 2%	585108-35	CG, C4
R11	510, 1/2W, 2%	585326-101	CG, C5
	Zener Voltage Regulator		
VR1	1N4741A, 10V	588102-8	MA
	Schematic Diagram	C982112	SR

Table 6-5
Replaceable Parts List
Base Drive PCB Ass'y 166088-1
STM Module IIIA Only
(Ref. Fig. 5-9, P. 5-15)

CIRCUIT SYMBOL	STM Models 3.5-36	5-36	9-20	12-20	15-15	18-15	24-13	28-11	36-6	48-5	DESCRIPTION	SORENSEN PART NUMBER	MANUFACTURER, TYPE
C19	x	x	x	x	x	x	x	x	x	x	Cap., 0.003uF, 600V	235-7207P51	SP
C20	x	x	x	x	x	x	x	x	x	x	Cap., 0.003uF, 600V	235-7207P51	SP
											Diodes		
CR1	x	x	x	x	x	x	x	x	x	x	400V	586379-6	SEM, S1F4
CR2	x	x	x	x	x	x	x	x	x	x	400V	586379-6	SEM, S1F4
CR3	x	x	x	x	x	x	x	x	x	x	1000V	587565-6	SEM, SOM
CR4	x	x	x	x	x	x	x	x	x	x	1000V	587565-6	SEM, SOM
CR5	x	x	x	x	x	x	x	x	x	x	50V	586379-1	SEM, S1F05
CR6	x	x	x	x	x	x	x	x	x	x	400V	586379-6	SEM, S1F4
CR7	x	x	x	x	x	x	x	x	x	x	50V	586379-1	SEM, S1F05
CR8	x	x	x	x	x	x	x	x	x	x	50V	586379-1	SEM, S1F05
CR9	x	x	x	x	x	x	x	x	x	x	400V	586379-6	SEM, S1F4
CR10	x	x	x	x	x	x	x	x	x	x	50V	586379-1	SEM, S1F05
											Transistors		
Q1A	x	x	x	x	x	x	x	x	x	x	2N2219A, NPN	386-7249P32	GE
Q1B	x	x	x	x	x	x	x	x	x	x	2N2219A, NPN	386-7249P32	GE
Q2A	x	x	x	x	x	x	x	x	x	x	2N2219A, NPN	386-7249P32	GE
Q2B	x	x	x	x	x	x	x	x	x	x	2N2219A, NPN	386-7249P32	GE
											Resistors		
R1A	x	x	x	x	x	x	x	x	x	x	12 ohms, 1/2W, 10%	280-1145P5	AB, EB
R1B	x	x	x	x	x	x	x	x	x	x	12 ohms, 1/2W, 10%	280-1145P5	AB, EB
R2A	x	x	x	x	x	x	x	x	x	x	12 ohms, 1/2W, 10%	280-1145P5	AB, EB
R2B	x	x	x	x	x	x	x	x	x	x	12 ohms, 1/2W, 10%	280-1145P5	AB, EB
	x	x	x	x	x	x	x	x	x	x	Schematic Diagram	B166086	SR

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